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National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii

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COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

Studies Completed on Variability in Anchovy Recruitment

Dr. Randall Peterman, from Simon Fraser University, Burnaby, British Columbia, Canada, completed his National Research Council research associateship in the Coastal Division in August. His research was on the sources of interannual variation in abundance of recruits of marine fish species, particularly the northern anchovy. With Michael Bradford, his associate, he completed a paper titled "Wind speed index correlates with mortality rate of a marine fish, the northern anchovy (Engraulis mordax)."

In this paper they showed that the frequency of periods with calm winds during the spawning season accounts for 65% of the interannual variation in mortality of northern anchovy larvae, possibly because calm winds permit maintenance of concentrated patches of larval food. Neither cannibalism on larvae nor offshore transport contributed significantly to variability in this mortality.

In another paper still in preparation, they state that reconstructed abundances (1965-85) showed that the number of larvae surviving through this early larval stage is not correlated with abundance of recruits. An empirically-based simulation model showed that the probability of observing a correlation between age 1 recruitment and abundances at earlier life stages is affected by several variables not controllable by man. Together, these results strongly suggest that further research is needed on the late juvenile stage to fully understand variability in recruitment. (R. Lasker, FTS 893-6212)

COASTAL EASTERN PACIFIC POPULATION BIOLOGY OF FISHES

Sardine Mortality Correlated with Anchovy Biomass

Fishery Biologist John Butler has analyzed larval sardine mortality rates from sized larvae in the data series from 1951 to the present of the California Cooperative Oceanic Fisheries Investigations (CalCOFI). Using growth rates derived from daily increments in the otoliths of sardine juveniles, he has made the first estimates of larval sardine mortality rates.

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The population of Pacific sardine declined steadily from 1951 to 1967 and a moratorium on commercial fishing was imposed in 1967. This decline has been attributed to overfishing during periods of poor recruitment. Although overfishing of the sardine stock has been well documented, no explanation for the poor recruitment has yet been advanced. Butler performed a simple correlation analysis and found that over 60% of the interannual variation in larval sardine mortality rates can be explained by the increase in anchovy biomass (Figure 1). Although anchovy are known to cannibalize their own eggs and larvae, this is the first time that predation by anchovy has been implicated as a source of mortality on other fish stocks. Butler's results suggest that the northern anchovy may have contributed to the poor sardine recruitment by increasing larval mortality rates. (J. Butler, FTS 893-6316)

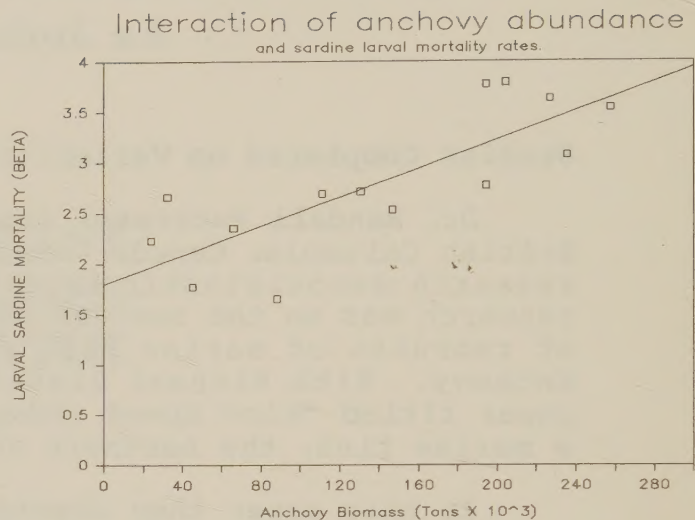


Figure 1

SURVEY SYSTEMS DEVELOPMENT AND EVALUATION

Second Expanded Sardine Survey Completed

Under the scientific leadership of Biologist Patricia Wolf, California Department of Fish and Game, and Fishery Biologist Dr. Paul Smith, the second survey of the expanding sardine stock was conducted from August 4 to 13, 1986. The survey procedure was supervised by California Department of Fish and Game biologist Cheryl Scannell. The cruise was conducted from Point Conception to San Diego and out to the Channel Islands from the ship Van Tuna of Occidental College, on contract to the California Department of Fish and Game. Two other fishing vessels collected samples of the adult sardines by purse seine and trawling. Most procedures were identical to those used for the Southwest Fisheries Center Egg Production Method to estimate the anchovy biomass.

The samples are now being sorted and should be completed by early September with the data base entered in the California Cooperative Oceanic Fisheries Investigations (CalCOFI) data base by mid-September. A preliminary report of the cruise will be delivered at the annual CalCOFI meeting in Lake Arrowhead October 23. A final report of the extent of the spawning area will be

drafted in November for management considerations and a final report of the adult and sample parameters will be completed by spring 1987. (P. Smith, FTS 893-6346)

EDMAP Contouring Program Moved to Microcomputer

In a continuing effort to save money on mainframe computer use, Oceanographer Larry Eber has begun the process of transferring the EDMAP Contouring program from the UCSD Vax to the Survey Systems IBM PC AT. This contouring program, which was developed by Eber, has been used widely for making contour survey maps and statistical summaries and displaying fishery models like yield isopleths.

The current configuration of the system on which the EDMAP system will be installed is an AT system with 2 1.2 Mbyte disc drives and 2 20 Mbyte Bernoulli disk drives. The software and documentation for use on the Vax-VMS system are now available in PASCAL and the microcomputer version should be ready later this year. (L. Eber, FTS 893-6282)

COMMERCIAL AND RECREATIONAL FISHERIES RESEARCH FOR MANAGEMENT

Solution to the Statistical Errors-in-Variables Problem Investigated

Estimates of optimum yield, optimum sustainable population, and most other fishery management criteria, depend heavily on statistical regressions. These regressions describe the average relationship between a quantity in which one is interested (the dependent variable) and one or more quantities which one can measure (the independent variables). A typical regression used to provide fishery management information is a stock-recruitment curve which describes the recruitment expected from various stock sizes and environmental conditions. Another example is the production or equilibrium yield curve, which describes population growth or sustainable harvest at various stock sizes or levels of fishing intensity.

Existing regression methods require that the independent variables (stock sizes and environmental conditions in the above examples) be known without error. Fishery science, with its pervasive problem of measurement imprecision, is almost never able to meet this requirement. Violation of the requirement is called the problem of "errors-in-variables." The effect of errors in variables is to create a bias which makes recruitment falsely look independent of stock size, or makes sustainable yield curves appear asymptotic rather than dome-shaped, perhaps dangerously underestimating the influence of fishing intensity.

Unfortunately, there are very few methods which can address the problem of errors-in-variables, and none of them include general nonlinear and/or multivariate regressions. Fishery Biologist Alec MacCall and NOAA Junior Fellow John Michno are investigating a new and generally applicable solution based on the Delta Method. This method estimates the bias as the sum of the contributions from the influence of the error in each observation of the independent variables. This contribution is related to the product of the error variance associated with the observation (assumed to be known, but a reasonable guess should suffice) and the second partial derivative of the parameter being estimated (e.g. maximum sustainable yield) with respect to the value of that observation. Covariances in observation errors are treated similarly, using mixed partial derivatives. The partial derivatives must be estimated numerically, requiring several model fits for each datum, easily numbering hundreds or thousands of re-estimations of the regression.

The computationally intensive nature of the method lends itself well to microcomputers for routine application. However, present testing of the method is based on numerous applications to simulated data sets; because this may require over 100,000 model fits, the work is being done on the CRAY supercomputer at the University of California, San Diego, which is the only means by which results can be obtained in a reasonable length of time. Initial results from simple simulated data suggest that the new method performs well. (A. MacCall, FTS 893-6209)

Report on Economics of Pacific Coast Fishing Fleet

Industry Economists Daniel Huppert and Cynthia Thomson completed "A Report on the PacFIN Research Data Base for 1983 and 1984" (SWFC Administrative Report LJ-86-20). The Pacific Fisheries Information Network (PacFIN) Research Data Base for 1983 and 1984 (like the 1981 and 1982 versions) describes landings, revenues and characteristics of Pacific Coast commercial fishing vessels. The data base is particularly suited for economics research because it describes fishing activity on a vessel-by-vessel basis.

The report describes (among other things) aggregate landings by species and state, frequency distributions for vessel length and gross revenue, the number of vessels according to principal species, gear and port, and the extent of inter- and intra-state fishing activity.

Table 1 illustrates some of the information contained in the report. According to the table, 75% of all vessels which made landings in 1983 and 60% which landed in 1984 earned less than \$5000 in gross revenue--attesting to the substantial number of vessels that are marginal producers in the fleet. The total number of vessels declined by 29% (from 13615 to 9628) between

1983 and 1984. Most of this decrease occurred among salmon trollers which made less than \$5000 in 1983. (C. Thomson, FTS 893-6225)

Table 1. Number of vessels associated with selected principal species groups in 1983 and 1984.

Principal species groups*	Number of vessels:			
	Overall	Gross rev. > \$5k		
	1983	1984	1983	1984
Chinook salmon	4469	2893	356	634
Coho salmon	2365	936	92	232
Pink & sockeye salmon	663	569	119	365
Other salmon	593	427	128	128
Unspecified rockfish	986	854	291	251
Herring	384	225	349	118
Albacore tuna	632	570	422	310
Yellowfin tuna	103	36	76	29
Sharks	96	100	27	34
Billfish	193	231	146	190
Pink shrimp	101	63	100	57
Dungeness crab	997	976	646	649
Crustaceans	225	214	95	83
Northern anchovy	8	13	6	10
Mackerels	71	59	50	52
Echinoderms	184	154	111	98
Miscellaneous fish	405	318	74	95
Sablefish	62	48	50	41
Ling cod	121	1	13	0
Halibut (Calif. & Pacific)	206	194	118	130
Others	751	752	387	436
Total	13615	9628	3656	3942

* Principal species group defined as that species group which accounts for more of a vessel's revenue than any other group.

Issues in Measuring Economic Productivity of the Pacific Trawl Fleet

Dr. Dale Squires, Industry Economist, has recently completed a study of the theoretical and empirical issues required for constructing measures of total factor productivity in the Pacific trawl fleet. The empirical results are subject to revisions subsequent to refinement of the data base. The results will be issued as a NOAA Technical Memorandum.

Total factor productivity (TFP) traditionally explains the physical output per unit of input. The total growth rate of outputs (catch) is resolved into two components: the growth rates

of inputs (capital, labor, fuel) and a residual identified with changes in the efficiency of production or technological progress (adoption of innovations which expand fishing power). In marine harvesting industries the TFP residual also includes the effects of changes in resource abundance and composition, multiproduct economies of scale, and capacity utilization of capital. Changes in resource abundance and composition can either reinforce or counteract the productivity trend associated with technical progress.

The empirical study examines TFP in Washington, Oregon, and Northern and Central California, and the entire fleet from 1981-1985. Eight species groupings are considered: Dover sole, Petrale sole, other flatfish, rockfish, Pacific cod and ling cod, sablefish, Pacific whiting, miscellaneous groundfish, and pink shrimp. The Pacific trawl fleet includes otter trawlers harvesting groundfish, pink shrimp trawlers, and midwater trawlers targeting Pacific whiting and shortbelly rockfish in joint venture operations.

Tornqvist bilateral chain indices for TFP are presented in Table 1 for each region and the entire fleet. These are economic indices which consider proportional changes between time periods in which each period's value (e.g., tons of crab) is weighted by its share of total revenue. They are bilateral indices because only one region at a time is considered. The fleet indices are share-weighted composites of the individual region's indices. All results are compared to 1981 values. The results indicate an important decline in TFP during 1982 and 1983 relative to 1981. TFP then grew in 1984 and 1985, surpassing the 1981 level. The regional TFP indices indicate that by 1984 Washington and Oregon surpassed the 1981 level but that Northern and Central California have not. The industry mean TFP growth rate for 1981-1985 is around 2% with substantial variation over time and regions.

Table 1. Indices of total factor productivity.

Year	Washington	Oregon	N. Calif.	C. Calif	Fleet
1981	1.000	1.000	1.000	1.000	1.000
1982	0.944	0.891	0.738	0.916	0.869
1983	0.995	0.812	0.693	0.679	0.792
1984	1.152	1.041	0.799	0.928	0.985
1985	1.249	1.258	0.813	0.887	1.078

The 1982-1983 productivity decline may in large part be due to the excessive exploitation of the widow rockfish stock and decline of the pink shrimp trawl sector by a fleet that had undergone substantial expansion after the Magnuson Fisheries Conservation and Management Act. Rockfish and pink shrimp are by far the two most important species groupings by share of total

revenue. Industry aggregate output as a whole declined by about 1% in 1982 and 5.5% in 1983. Industry aggregate input grew by 13.5% in 1982 and by 3.7% in 1983, making an important contribution to the 1982-1983 decline.

The TFP rise in 1984 and 1985 can be attributed to an increase in aggregate output, and more importantly, to a precipitous and continuous decline in aggregate input. Industry aggregate output grew by 0.5% in 1984 and declined by 0.3% in 1985. No individual species dominates the increase in aggregate output, although pink shrimp is apparently beginning a resurgence. Industry aggregate input declined at a rate of 21% in 1984 and 9.3% in 1985. Capital began to decline in Washington and Oregon in 1983, while both Northern and Central California experienced capital increases in 1983 before declines in 1984. Many vessels left the fleet due to sinkings, burnings, financial difficulties, or transferring to Alaska.

Both industry (implicit) aggregate output and input real price declined until 1985, when the aggregate input price increased to above the 1981 level. This recent price-cost squeeze counters, at least in part, gains in industry economic performance due to the recent rise in productivity. (D. Squires, FTS 893-6309)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION La Jolla, California

FISHERY DEPENDENT DATA

Study Begins to Assess Utility of Tuna-Vessel Observer Data for Determining Long-Term Trends in Dolphin Abundance

In answer to such questions as "how do tuna vessels search for dolphin, how do they find them, and how do the data that observers on these boats collect relate to the true distribution and abundance of dolphin," Dr. Elizabeth Vetter, Operations Research Analyst, has begun developing two models: a spatially distributed, dynamic simulation model of the tuna-dolphin system in the eastern tropical Pacific (an environmental model), and a tuna-fishing system model, which will be superimposed on the environmental model. The answers to these questions are important in determining the trends in abundance of dolphin populations involved in the tuna purse-seine fishery in the eastern tropical Pacific.

To determine trends in abundance, biologists of the dolphin monitoring program use three kinds of data: abundance indices collected during carefully designed research surveys, abundance indices collected by observers on U.S. tuna vessels, and estimates of population parameters such as birth rates, sex ratio, and age structure, also collected by the observers placed aboard tuna vessels.

The research surveys are a very costly method of indexing abundance. A popular suggestion has been to ask tuna-vessel observers to collect the same sort of information previously collected by the research vessels. The potential for using data collected from these vessels to index population trends appears great because tuna vessels far exceed research vessels in both number and area covered during a trip. The problem with using data from tuna vessels, however, is that existing methods and theory for deriving estimates of abundance or trends in abundance depends strongly on the assumption that the data were collected in a random manner. This led to the questions on how tuna vessels search for dolphin, how they find them, and how the data that observers on these boats collect relate to the true distribution and abundance of dolphin.

The direct approach to answering these questions is to run research surveys, which would be designed to search randomly, concurrently (in both space and time) with normal fishing operations by the tuna fleet. Even in small lakes, such an endeavor would be extremely complex and expensive; in a system as large as the eastern tropical Pacific Ocean, it may be impossible.

An alternative is provided by the method of system simulation and analysis. This involves developing mathematical models that simulate the dynamics of the relevant state variables (in this case, dolphins, tuna, observers, and fishermen) and the processes that control these dynamics (such as oceanographic conditions and the price of tuna), then "collecting" data from the simulated system just as one would from the real system. In this case, simulated observers would be "sent" aboard some subset of the vessels in the simulated tuna fleet; during their cruise they would "collect" the same type of data as real observers. The data collected from the simulated fishery are then analyzed by whatever methods have been proposed for the data from the real fishery, and estimates are made of dolphin abundance, or trends.

Unlike the case for the real fishery (without concurrent research cruises), in the simulated system both bias and precision can be tested. One has not only the estimates derived from the (imperfect but realistic) sampling of the simulated tuna fleet, but also, because one has the underlying systems models, the "true" abundance and distribution of dolphins. A primary advantage of the approach is it becomes possible to test relatively efficiently many more alternative methods under many different hypotheses about fleet configuration, oceanographic condition, dolphin and tuna distribution and abundance, and economic constraints. Basically, it offers a cost-effective procedure for eliminating inappropriate analyses. Methods that do not work for the (by necessity less complex than the real thing) simulation models have little hope of being effective in the real world.

For the development of Vetter's models, she will proceed at least partially with the aid of two systems modeling programs made available only recently for use on microcomputers: 1) STELLA, which runs on the Macintosh and 2) CSMPC, which runs on IBM and compatible machines. CSMPC is a translation of the extensively used simulation program CSMP, developed originally for IBM mainframes. STELLA is a remarkably effective, efficient, and easy-to-use program developed specifically to take advantage of the Macintosh graphics capacity.

Details of the models, such as relevant level of model complexity, development of rules-sets for movement between spatial domains by tuna, dolphins, and fishermen, and so forth, will be determined over the next several months on the advice of experts in the various fields these models will encompass--from biologists to economists to systems analysts. (E. Vetter, FTS 893-6285)

FISHERY INDEPENDENT DATA

Estimates of Porpoise Mortality Stratified by Month

On July 14, 1986, a briefing for the Marine Mammal Commission was organized by the National Marine Fisheries Service for the purposes of (1) reviewing various methodologies for estimating the mortality of porpoises killed incidentally in the tuna fishery in the eastern tropical Pacific in calendar year 1986, and (2) reviewing the methodology for estimating the size of yellowfin tuna caught with and without associated porpoise. The meeting, which was held at the Southwest Fisheries Center in La Jolla, was attended by: Dr. Izadore Barrett, Director; Dr. Douglas DeMaster, Supervisory Wildlife Biologist; Bruce Wahlen, Statistician; and representatives of the Marine Mammal Commission, the tuna industry, and the Southwest Regional Office. Gary Smith, Deputy Director (SWR), chaired the meeting. The panel members concluded at the end of the briefing that, to reduce bias, an alternative stratification scheme, stratifying by month as opposed to the current scheme of stratifying by 3 month periods, should be considered to reduce bias. Furthermore, it was agreed that the Center staff should complete this analysis by August 15, 1986.

Recently, Bruce Wahlen and Ken Wallace, Computer Programmer, completed the estimate of dolphin mortality based on monthly stratification. The mortality for each stock within a stratum was estimated as the product of the observed kill-per-vessel-day rate for a species or stock for a stratum and the total number of vessel-days at sea in that stratum. This was for vessels authorized to fish on dolphins in the General Permit Area within the ETP. The observed kill-per-vessel-day rate for a stock was computed as the quotient of total kill for a stock in a stratum and the total number of vessel-days for all observed trips (completed trips or those still at sea in that stratum. The equations that were used to estimate mortality by stratum are the same as those published in the 1977 Federal Register notice. The estimate of total mortality for a stratum was based on the observed rate of kill-per-vessel-day over all stocks. The total kill from January 1986 to July 20, 1986, was estimated by summing kill estimates over all strata.

A portion of the results of the analysis is provided in Table 1. The coefficient of variation for all stocks was 0.15, which is comparable to the CV of the currently used method. The results were distributed to all panel members and to the Southwest Region. The Region, in consultation with headquarters in Washington, D.C., will make a final determination as to which estimator will be used to estimate dolphin mortality in 1986. Wahlen, Wallace, and Carolyn Macky, Statistician, are currently working on a more comprehensive analysis of estimating incidental porpoise mortality. This study will be completed in November 1986. (D. DeMaster, FTS 893-6266)

Table 1. Summary of analysis of total dolphin mortality (all stocks) based on monthly strata. Data are from January 1, 1986, through July 20, 1986.

Stratum	# obs days	Obs kill	Kill /day	# fleet days	Est kill /month	St Err	Cumul kill
1/1-2/2	166	440	2.65	382	1013	386	1013
2/3-3/2	156	993	6.37	409	2603	504	3616
3/3-3/30	156	1420	9.10	398	3623	1281	7239
3/31-4/27	204	484	2.37	606	1438	339	8677
4/28-5/25	163	1459	8.95	564	5048	2017	13725
5/26-6/22	85	625	7.35	473	3478	676	17203
6/23/7/20	235	362	1.54	457	704	280	17907

ETP Dolphin Survey Is Underway

A 5-year program to measure the abundance of dolphins in the eastern tropical Pacific was launched on July 29, 1986, as 12 scientific observers and Cruise Leaders Rennie Holt and Steve Reilly left aboard the NOAA Ships David Starr Jordan and the McArthur for a 4-month cruise to survey dolphins. This survey is the first of six surveys, which will be conducted during the next 5 years.

Based on line transect procedures, the ships are traversing the 5 million square mile range of dolphins associated with tuna. The surveys have been designed to detect a 41% cumulative decline in abundance at the end of the 5-year program with a 90% probability of detection. The survey area is stratified into five zones, which are based roughly on historical density (Figure 1). Survey operations, such as dates, procedures, and tracklines, will be the same for all six surveys to ensure that annual indices of abundance are comparable throughout the 5 years.

The cruise is organized in four legs and will last from July 29 to December 6, with stops along the way at Manzanillo, Mexico; Hilo, Hawaii; Panama City, Republic of Panama; and Guayaquil, Ecuador. The ships will travel in predetermined patterns, as two teams on each ship search through 25 x 150 binoculars. The binoculars are connected to a CAST (computer aided sighting technique) system, which was developed by Holt to increase the precision of the survey results. By visually tracking a school of dolphins for up to 20 minutes an estimate of their distance from the ship is generated by the CAST computer. As the school is tracked, the observers estimate the number of dolphins and species composition of the school.

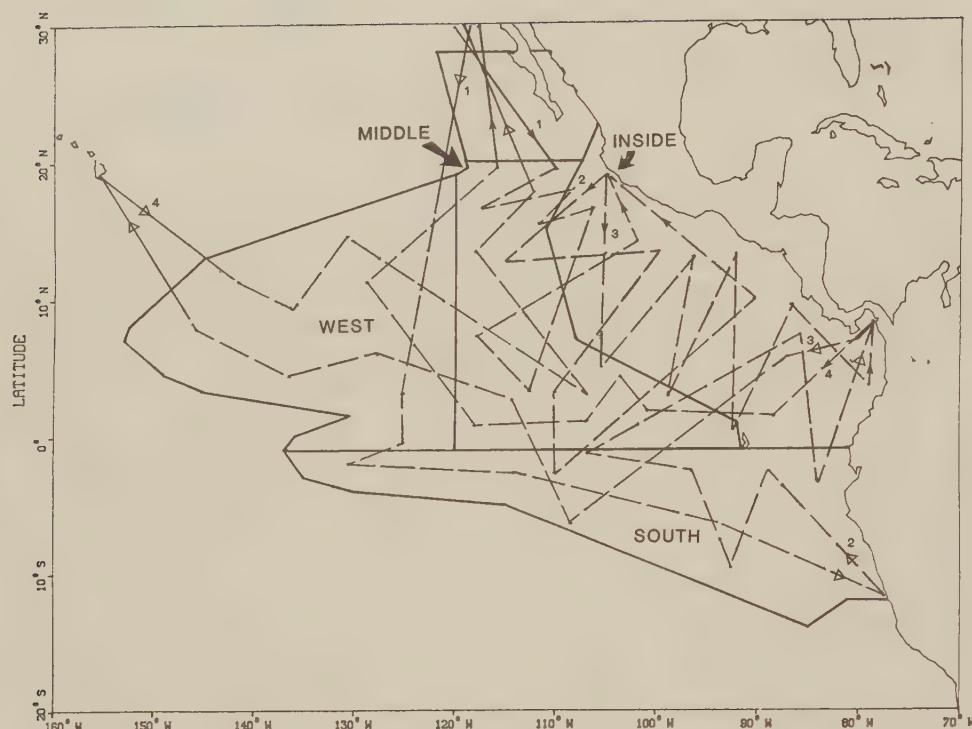
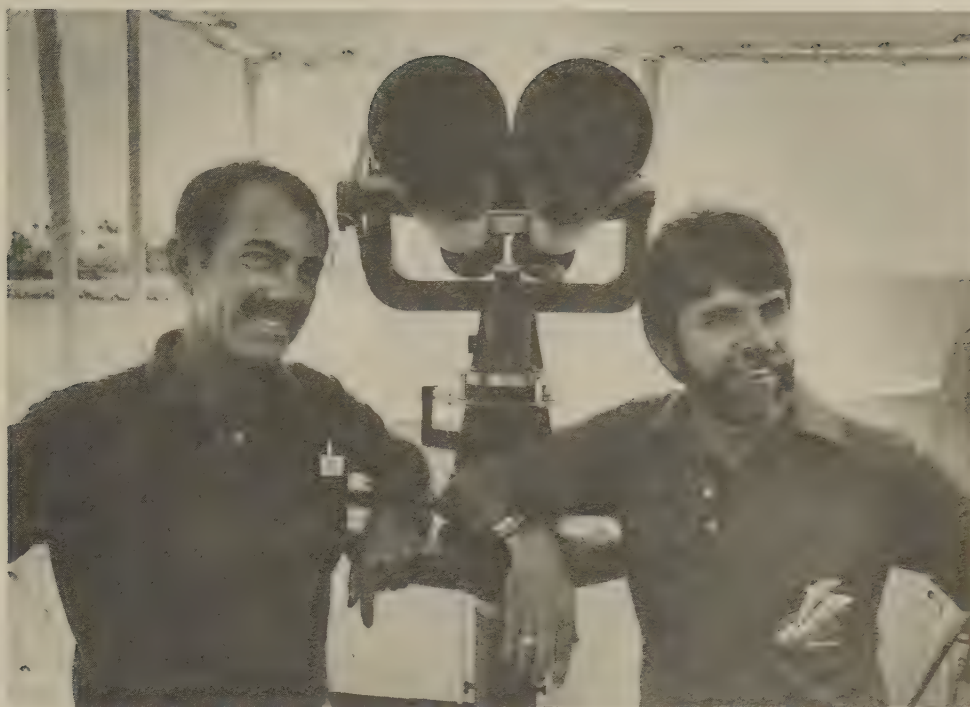


Figure 1. Tracklines for Jordan and McArthur assuming 120 searching days for each vessel. Arrows indicate direction of travel. Closed arrows are Jordan tracks and open arrows are McArthur tracks. Breaks in tracklines indicate area covered at night. (Actual track lines surveyed aboard the McArthur changed from those shown in the figure because of problems with refueling.)

By the end of the program scientists will be able to compare the data from each cruise and determine if stocks of dolphins in the ETP are increasing or decreasing.

The secondary objectives of the survey, which were coordinated by Reilly, are to collect information to investigate the physical and biological environment of the eastern tropical Pacific. Both vessels have Conductivity Temperature Depth (CTD) systems and will collect samples from an average of 4 stations per day. In addition, 4-6 expendable bathythermographs (XBTs) will be dropped each day. Each vessel will also collect continuous flow data on temperature, salinity, and fluorometry. NOAA's Atlantic Oceanographic and Meteorological Laboratory and the U.S. Tropical Ocean Global Atmosphere program have contributed equipment and manpower to collect the environmental data.

This first cruise is the culmination of years of planning. Chief Scientist Rennie Holt designed the surveys, and Cruise Coordinators Wes Parks and Pete Stangl worked on the details and logistics of the surveys. (P. Stangl, FTS 893-6251)



Cruise coordinator West Parks (left) and Chief Scientist Rennie Holt with a set of binoculars before leaving for the eastern tropical Pacific. (Los Angeles Times photo)



Observers for the survey, from left to right: Bill Irwin, Bob Pitman, Scott Sinclair, Mark Webber, Mike Newcomer, Richard LeDuc, Carla Bisbee, Kurt Brownell, Larry Robertson, Pete Stangl, Andy Dizon, Scott Benson, David Skordal. Not shown are Liz Vetter and Steve Buckland.



Captain and crew of the David Starr Jordan.



Captain and crew of the McArthur.

HONOLULU LABORATORY

Honolulu, Hawaii

INSULAR RESOURCES INVESTIGATION

Honolulu Laboratory Scientist Attends Meeting in Soviet Union

Dr. George W. Boehlert, Chief, Insular Resources Investigation, attended the First Pacific Symposium on Marine Sciences, which was held in Nakhodka, U.S.S.R., from August 7 to 16, 1986. The meeting was organized by the Scientific Committee on Marine Sciences of the Pacific Science Association, an international nongovernmental body devoted to initiating and promoting cooperation in solving scientific problems of the Pacific Basin. The committee is composed of marine scientists from several Pacific nations. The American members of the committee are Boehlert, James C. Kelley, San Francisco State University, and Gunter R. Seckel, formerly Chief of the Pacific Fisheries Environmental Group in Monterey. The committee is chaired by Academician V. I. Ilyichev, President of the Far Eastern Sciences Center and U.S.S.R. Academy of Sciences and also Director of the Pacific Oceanological Institute in Vladivostok.

The topic of the meeting was "Matter and Energy Exchange in Water Mass, Ocean-Atmosphere, and Water-Bottom Sediment Systems and Their Impacts on Biota." Several papers concentrated on physical oceanography in the North Pacific and others on biology and fisheries. Boehlert's paper was entitled "Current-topography interaction at mid-ocean seamounts and the impact on pelagic ecosystems." He met with several scientists from the Pacific Institute of Research on Fisheries and Oceanography to discuss common research interests in seamount oceanography. In the U.S.S.R. the foreign participants visited many of the scientific institutes in Vladivostok and Khabarovsk. Plans were made for the second Symposium, which will cover the topic of marine resources of the Pacific Basin, to be held again in the U.S.S.R. in 1988. (G. Boehlert (808) 943-1221)

Quantitative Methods Used to Evaluate Mariculture Practices

The release of hatchery-reared juvenile fishes and crustaceans to enhance a fishery is practiced in Japan and to a lesser degree in other countries including the United States and Norway. This approach to fishery enhancement represents a marriage of traditional fishery science and mariculture. Standard quantitative fishery science methods can be modified and applied to juvenile releases for fishery enhancement. Dr. Jeffrey J. Polovina, Leader, Artificial Reef and Enhancement Program, has modified the Beverton and Holt yield-per-recruit model and the Ricker dynamic surplus production model to evaluate how the release of hatchery-reared juveniles affects the fishery.

Standard surplus production models are based on catch and effort data. Hatchery-reared juveniles released into a fishery add a third variable, stocking number, to the model. The Ricker surplus production model can be used to relate catch at year t (C_t), fishing effort at year t (E_t), and number of juveniles stocked at year t (H_t) with the following three equations:

$$B_{t+1} = S_t \exp(A - BS_t) + a(H_t)^b$$

$$S_t = B_t - C_t$$

$$C_t = B_t(1 - \exp(-qE_t)),$$

where B_t is the population biomass in year t , S_t is the biomass remaining after harvest in year t , and a , b , A , B , and q are parameters to be estimated from a nonlinear regression of the model with catch, effort, and stocking data. Examples of Ricker catch and effort curves with and without constant stocking are given in Figure 1. In the catch curve with stocking, a greater maximum yield and optimum effort are achieved, compared with the maximum yield and optimum effort of the catch and effort curve without stocking. When fishing mortality is high, the catch and effort curve with stocking approaches a positive lower bound.

Polovina applied the Beverton and Holt yield equation to hatchery releases to identify which biological characteristics of a species result in the greatest yield per stocked individual. The results indicate that species which have low mortality to growth ratios (M/K) and high asymptotic weight (W_{max}) will produce the greatest yield per stocked individual. A comparison of the maximum yield per stocked juvenile as a function of fishing mortality computed from the Beverton and Holt yield equation for mahimahi, opakapaka (a deepwater

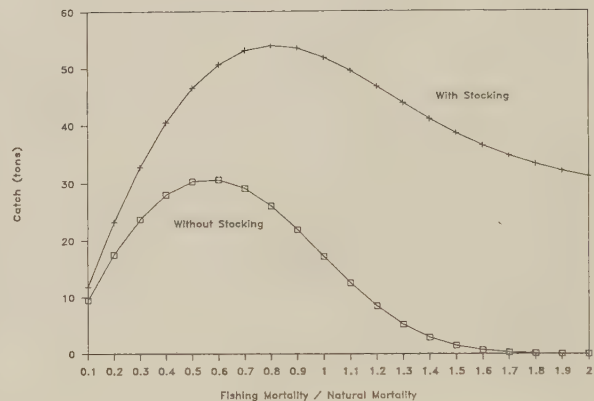


Figure 1. Ricker surplus production model with and without stocking.

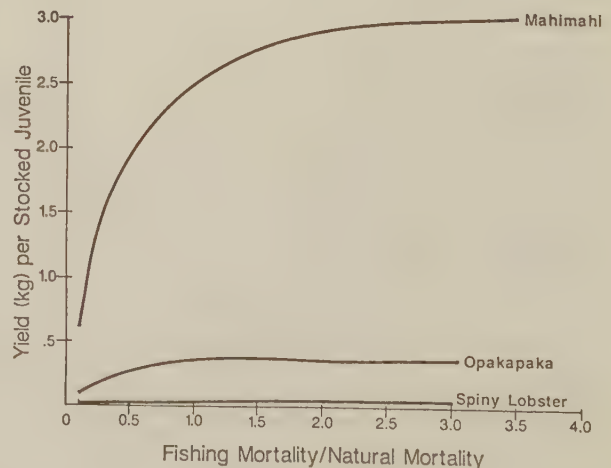


Figure 2. Yield per stocked juvenile for mahimahi, opakapaka, and spiny lobster.

snapper), and spiny lobster shows that if hatchery reared mahimahi, opakapaka, and spiny lobster were released into a fishery, a stocked mahimahi with its low ratio of M/K ($M/K = 1.0$) and high asymptotic weight ($W_{\max} = 30$ kg) would contribute over 2.5 kg per stocked individual to the fishery, whereas opakapaka with M/K of 1.7 and $W_{\max}$ of 8.5 kg only contributes about 0.4 kg per stocked individual to the fishery, and a spiny lobster with M/K of 3.0 and $W_{\max}$ of 1.7 kg contributes less than 0.1 kg per stocked juvenile to a fishery (Figure 2). Polovina will present the results of his study during a workshop on marine ranching at a meeting in Japan in September. (J. Polovina (808) 943-1221)

Book on Tropical Snappers and Groupers to Be Published

Drs. Jeffrey Polovina and Stephen Ralston, Fishery Biologists, have edited a book, "Tropical Snappers and Groupers: Biology and Fisheries Management," which will be published in December by Westview Press. The book is the result of a workshop held in May 1985 at the Honolulu Laboratory. This workshop brought together researchers from across the U.S. and Australia working on the biology and management of regional snapper and grouper stocks. Papers were presented that summarized current knowledge of these two groups and the resource-specific relationships of the biology and management aspects of these fish.

The first nine chapters are up-to-date summaries of the understanding of the biology of snappers and groupers. Included are papers on taxonomy, early life history, reproductive biology, age and growth, mortality, and trophics. The following five chapters deal with the assessment, economic, and management aspects of snapper and grouper stocks. A final chapter synthesizes the main points and identifies critical information gaps. Regional coverage ranges from fisheries in the western Pacific Ocean to the Caribbean Sea. The book can be purchased from Westview Press, 5500 Central Avenue, Boulder, CO 80301. (J. Polovina (808) 943-1221)

FISHERY MANAGEMENT RESEARCH PROGRAM

Strategic Planning Meeting Held

Following the workshop on "Forces of Change in Hawaii's Aku (Skipjack Tuna) Industry" (see Report of Activities, May-June 1986), a strategic planning meeting on the future of the skipjack tuna industry was sponsored by the Honolulu Laboratory on June 27 and 28. Ten representatives of the local industry and Hawaii government participated in the session which concentrated on discussing goals and objectives for rejuvenating Hawaii's aku fishery. The group completed a list of goals for guiding future

activities and proposed a set of activities to meet those goals. Some of the goals set out by the participants were to forecast aku availability, to increase state support for marketing, and to maintain a viable cannery. The results of the June session will be documented in a draft report to be reviewed by the group early in the fall. (S. Pooley (808) 943-1221)

Cooperative Economics Research Project Initiated

A cooperative research project on the economics of Hawaii's expanding lobster fishery was initiated by Samuel G. Pooley, Industry Economist, Paul Gates of the Western Pacific Regional Fishery Management Council, and Dr. Karl Samples of the University of Hawaii's (UH) Department of Agricultural and Resource Economics. Gates completed summarizing trip patterns based on logbook data compiled by staff of the Fishery Management Research Program at the Honolulu Laboratory. This information will be synthesized by Gates, Samples, and Pooley into a report on changes in fishery operations over the past 4 years. A survey of mainland U.S. wholesale markets and brokers of lobster was also completed by UH researchers. This information will be used to provide a picture of the marketing situation facing the Hawaii lobster fishery and to analyze the impact of regulations on the fishery. (S. Pooley (808) 943-1221)

Honolulu Laboratory Personnel Attend Council Meeting

Samuel Pooley, David Hamm, and Dr. Stephen Ralston attended the Western Pacific Regional Fishery Management Council's Scientific and Statistical Committee (SSC) and other meetings in Kona, Hawaii, from August 4-8, 1986. Center Director Dr. Izadore Barrett gave a presentation to the SSC on the program and budget of the Honolulu Laboratory.

During the meetings, the Council approved exploration of the rights of native Hawaiians in the limited entry proposal for the bottom fish fishery management plan. The Council also approved an emergency regulation to tighten the legal language pertaining to the closure of Laysan Island as a refuge from lobster fishing.

During the Hawaiian International Billfish Tournament, which was in progress at the same time as the Council meetings, fishermen caught record-breaking numbers and poundage of fish. The tournament's first 1,000-lb (454 kg) marlin was boated and more fish were caught on the first day than during the entire week last year. This year's tournament was also the first where fishermen tagged and released marlin under 200 lb (91 kg). (S. Pooley (808) 943-1221)

WPACFIN Meeting Held in Kailua-Kona, Hawaii

David C. Hamm, Computer Systems Analyst, participated in the seventh meeting of the Western Pacific Fishery Information Network's (WPACFIN) Fisheries Data Coordinating Committee (FDCC) in Kailua-Kona, Hawaii. All WPACFIN participating agencies were represented, including the American Samoa Office of Marine and Wildlife Resources, Hawaii Division of Aquatic Resources, Guam Division of Aquatic and Wildlife Resources, Division of Fish and Wildlife of the Commonwealth of the Northern Mariana Islands (CNMI), Western Pacific Regional Fishery Management Council, Western Pacific Program Office (WPPPO) of the Southwest Region, and the Honolulu Laboratory. Also present was a representative of the NOAA General Counsel to help in the discussion on data confidentiality and data sharing. Progress was made in resolving some of the differences between agencies concerning laws of confidentiality. Neither American Samoa nor the CNMI has laws governing confidentiality of data, but agencies from both areas will be submitting requests for legislation in the next sessions of their legislatures. The NOAA General Counsel will provide assistance to make sure the laws are compatible with NMFS regulations on confidentiality. (D. Hamm (808) 943-1221)

PELAGIC RESOURCES INVESTIGATION

Manuscript Completed on Parasite Found in Yellowfin Tuna

Dr. Richard W. Brill, Leader, Tuna Behavior and Physiology Program, reports that a manuscript (co-authored with Robert E. Bourke and Dr. James Brock) describing the effects of a larval cestode (tapeworm) parasite that infests the dorsal aortas of small yellowfin tuna, Thunnus albacares, has been completed. This cestode, Dasyrhynchus talismani, is common around Hawaii, infesting at least some blood vessels of up to 60% of all yellowfin tuna, and is found in the dorsal aortas of up to 60% of small (<3 kg) yellowfin tuna. The parasite is also common in yellowfin from the Atlantic Ocean and Gulf of Mexico.

Because the worms and the tissue that is produced as part of the host's immune response appear to occlude the dorsal aorta almost completely, Brill hypothesized that this parasite could be an important factor in the natural mortality of small yellowfin tuna and therefore it could have important fishery management implications. To test the hypothesis, relative condition factor and relative liver weight (both measures of starvation), relative heart weight (a measure of the increased blood pressure caused by blockage of the dorsal aorta), relative otolith weight (a measure of the fish's long-term growth rate) and RNA/DNA ratios (a measure of the fish's short-term growth rate) were determined from a large series of parasitized and nonparasitized yellowfin tuna. Surprisingly, no significant differences were found in any of these measured parameters. Therefore, in spite of the

apparent blockage of the dorsal aorta (the major blood vessel that collects oxygenated blood after it passes through the gills), the parasite is unlikely to have significant effects on natural mortality.

One surprising development from the study was the discovery of a dramatic change in the incidence of parasite infestation in small yellowfin tuna caught near Hawaii during August and September 1985. It is possible that this could indicate the influx of a separate population of small yellowfin tuna into the Hawaiian fishery at that time. The larval cestode parasite could therefore serve as a natural "tag" for determining the movements of small yellowfin tuna in the Pacific. (R. Brill (808) 943-1221)

FAD-Associated Skipjack Tuna Successfully Tracked

As part of a larger study to determine the behavior of commercially important pelagic fish species associated with fish aggregating devices (FADs), and to predict optimal FAD placement strategies, three skipjack tuna, Katsuwonus pelamis, were tracked using ultrasonic depth sensitive transmitters. The project is part of a joint research effort between staff of the Tuna Behavior and Physiology Program and Dr. Kim Holland of the UH's Hawaii Institute of Marine Biology and the Sea Grant College Program.

The fish were caught near FADs located off leeward Oahu, Hawaii, and followed using the RV Kaahale'ale for up to 56 hours. Unlike the yellowfin tuna that have been tracked as part of this project, all skipjack tuna remained essentially near the buoys during the time they were followed. Yellowfin tuna usually move offshore away from the FADs at night and return the next morning. Also, unlike skipjack tuna tracked away from FADs some years earlier which regularly moved up down in the water column, the FAD-associated skipjack tuna remained continuously in the upper 50 m. Further skipjack tuna tracking is planned for the remainder of the summer and fall. (R. Brill (808) 943-1221)

Kewalo Research Facility Is Regular Stop for Tuna Purse Seiner Skippers

Thanks to the efforts of John DeBeer, Director, Resourcing and Vessel Management, Van Camp Seafood Division, Ralston-Purina Company, the Kewalo Research Facility (KRF) has been a regular stopover for purse seiner skippers on their trips to American Samoa. Five captains have visited the KRF so far this summer. These visits provide useful exchanges between industry and the staff of the Tuna Behavior and Physiology Program. The captains are able to learn more about the current research activities of the program and the researchers are able to gain valuable

insights about tuna behavior that the captains have acquired from the many years they have spent observing and fishing tuna in different parts of the Pacific. (R. Brill, (808) 943-1221)

DATA MANAGEMENT AND TECHNICAL SERVICES

Turbo Pascal Installed in Molecular System

David C. Hamm, Acting Chief, Data Management and Technical Services (DMTS), reports that Turbo Pascal has been installed on the Honolulu Laboratory's Molecular 32X system. This is the CP/M 80 version of the combined editor and Pascal compiler developed by Borland International. It is a general purpose programming language intended for use by people who have specialized computing needs not met by standard applications packages. This version of Turbo Pascal is source-code compatible with the version installed on the Laboratory's IBM PC-AT's.

In addition, the SAS-PC software was upgraded from release 6.01 to 6.02 on all of the Honolulu Laboratory's six original IBM PC-AT's. In addition to a new SAS/BASE module, the upgrade includes the new SAS/STAT module which allows use of more statistical tests that were previously available only on the UH's IBM mainframe computer. The SAS software comes from the vendor on 20 double-sided/double-density 360kB diskettes and normally takes about 1 hour to install on a PC's hard disk. However, by using a Bernoulli Box removable disk cartridge system and its associated software, the DMTS staff was able to reduce the time required to install SAS to about 10 minutes. The primary difference in time is due to the unreliability of the PC-DOS backup-and-restore software which is usually used to install SAS on a new system. Since all Honolulu Laboratory PC-AT systems are equipped with Bernoulli Box interfaces, the DMTS staff can download SAS onto a 10MB cartridge and then upload it onto the new system's hard disk in a very efficient manner by using a Bernoulli Box specifically dedicated to floating between systems for temporary use. This floating Bernoulli Box is also used by PC-AT system managers to backup their hard disks and to transfer large data sets between systems. (D. Hamm (808) 943-1221)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

Preliminary Results on Albacore Forecasting Model Reported

Fisheries scientists have long been interested in being able to forecast when, where and how many fish will occur in a fishery. The ability to forecast for the albacore fishery is especially important because the cost of search time to the fleet is high and there is a long history of research on the factors influencing albacore distributions (much of it done at the Southwest Fisheries Center). Dr. Roy Mendelssohn, Operations Research Analyst, and David Husby, Oceanographer, have been attempting to construct a fine scale (two weeks by one degree square) quantitative forecasting model of the albacore fishery off the west coast of the United States.

Initially, environmental data were extracted from the TDF-11 (tape data family, a commonly used file from the National Climatic Center of surface marine weather reports collected since the late 1800s) data set for Marsden squares 120, 121 and 157. From these, biweekly mean values and variances were calculated by one degree square for sea surface temperature (SST), and the two components of the wind speed. More robust measures of central tendency and spread were also calculated for each variable on the same time and space scales. Mendelssohn and Husby selected these variables based on previous work with tuna in the Gulf of Guinea which suggested that these variables are effective in forming forecasts. Surface data also are more complete time series than subsurface data and if real-time forecasts are to be developed wind and SST can be obtained relatively easily compared with other oceanographic variables.

The albacore catch data, provided by the Multispecies Data Management and Fisheries Monitoring Program in La Jolla, were carefully searched for bad values and outliers. Biweekly means by one degree square were calculated for albacore catch per unit effort (CPUE) by jig boats only. Robust measures of central tendency and spread were also calculated for CPUE.

Previous efforts in correlating environmental variables with fish catch or CPUE have concentrated on contemporaneous oceanographic conditions restricted to the areas where fishing occurs. This type of analysis ignores the oceanographic processes which precede fishing. Mendelssohn and Husby's results from the Gulf of Guinea suggest that conditions that occur before fishing takes place are the most important factors in forecasting CPUE. The variables in the analysis generally were left untransformed, thereby assuming that the relationships between the fish and the environment were linear.

Finally, when forecasting, it is not sufficient to examine just the areas where fishing has occurred. Suppose a moderate temperature correlates with high CPUE in areas where fishing has occurred. There may also be other areas that have the same temperature but have no fishing. In forecasting, it must be possible to discriminate between these types of areas. Analyses restricted to only the areas of fishing may not find relationships capable of this level of discrimination (i.e. the variables are perhaps necessary but definitely not sufficient) and it does not deal with the very real problem that in any area with no fishing there are missing data.

Preliminary efforts have been aimed at determining the appropriate time scales on which the environment affects the CPUE for albacore, determining the likely functional shapes of these relationships and in developing techniques for estimating relationships when there are missing data. As an initial effort, Mendelssohn and Husby looked at individual one-degree squares (thereby ignoring spatial effects), choosing the areas that had the highest number of biweekly periods in which there was at least some fishing. In all, some 24 areas were examined--all were situated around the inshore area from Baja California to the Canadian border (Figure 1).

Using a technique for estimating r-squares in a regression context when data are missing, they found that for each of the 24 areas the multiple r-squared between the contemporaneous (lag 0) environmental variables and CPUE for albacore were less than 0.1--that is, there is little evidence of a relationship. This is consistent with previous correlation studies. However, when using a method to calculate "optimal regressions" (in a sense to be made exact in a moment) they found very different results. For example, for 44°N, 125°W they obtained:

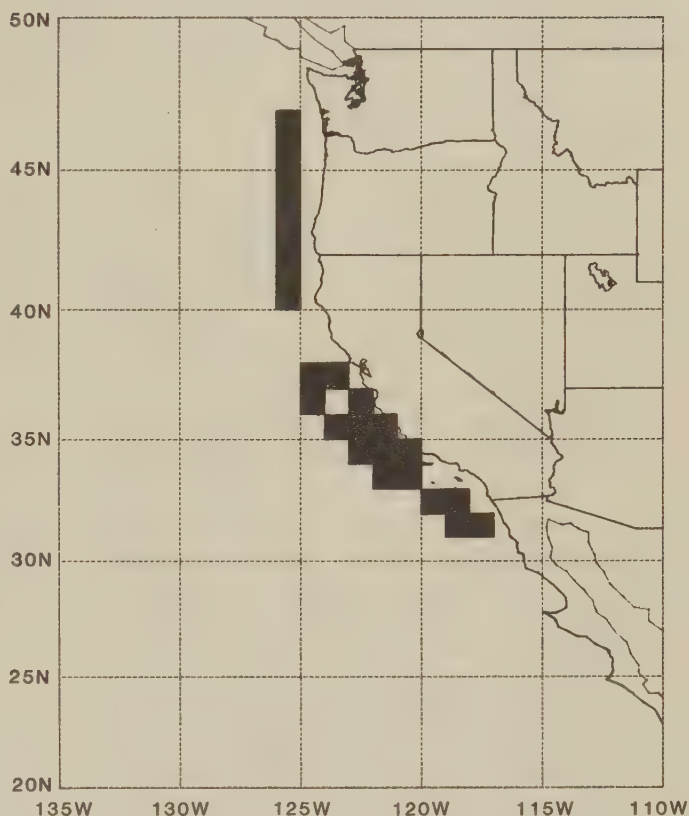


Figure 1. The 24 one-degree squares selected for preliminary analysis of the environmental influence on albacore CPUE.

Lags in modelEstimated r-square

0	0.35
0,1	0.67
1	0.65
1,2	0.68

Not only is the lag 0 r-square now much higher, but they found that the lag 1 model does just about as well as the model with both lags 0 and 1. This suggests that there is very little independent information in the lag 0 data. Moreover, where they originally found almost no predictability in the data, they found that almost 70% of the variance in the albacore CPUE can be explained. That pre-conditions are more important in explaining the presence of tuna is consistent with their previous studies of the Gulf of Guinea.

"Optimal regressions" are an algorithm developed by Breiman and Friedman that empirically calculates transformations of all the variables in a multiple regression so that the normalized sum of squares is minimized. For the two variable case, this would be equivalent to estimating empirically the transformation of each variable that produces the highest correlation between the variables. The algorithm helps in exploring the a priori belief that the relationship between CPUE and the environment is nonlinear, but of a shape not known.

The estimated transformation can be examined by plotting the original data against the transformed data. The transformations for CPUE tend to be close to a log transformation, a result which is not surprising considering that CPUE is the ratio of two variables. The estimated transformations for SST (Figure 2) are of a threshold type, and predicts

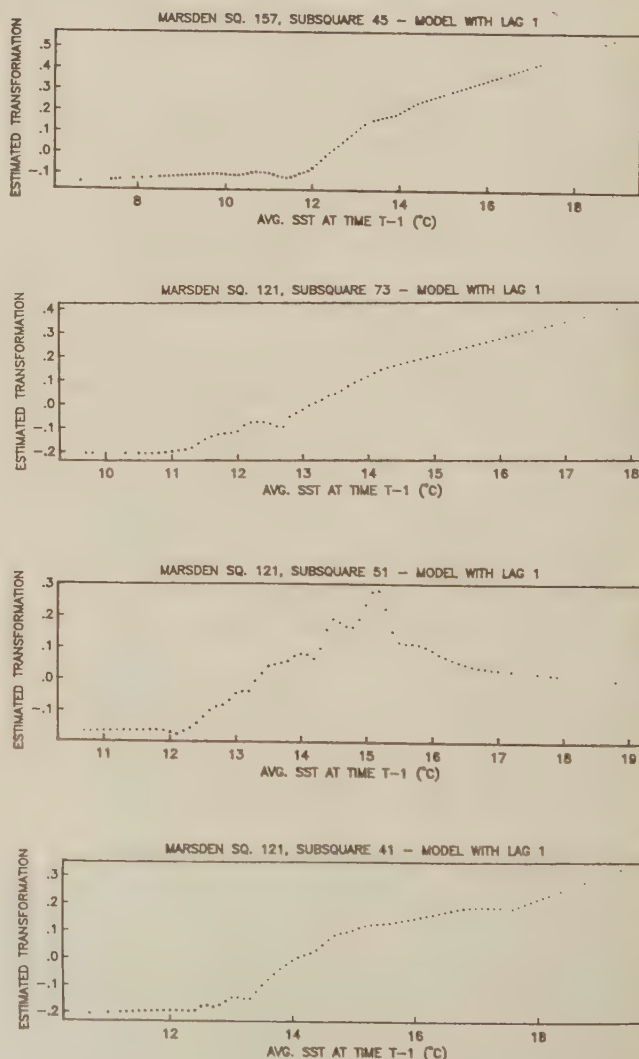


Figure 2. Plots of the estimated optimal transformation for SST versus the original SST data.

that the albacore should exhibit a preference for slightly colder water as location goes northward. This suggests that there is no single temperature that is "optimal" for albacore, but rather that the temperature reflects more favorable conditions for the albacore and the conditions will vary in space.

The estimated transformations for the two components of the wind speed (Figures 3 and 4) are highly nonlinear, with winds from the south and east having no effect at all. The "ideal" wind conditions appear to be a wind out of the north-northwest at roughly 7-10 meters/second speed. This type of wind is usually associated with upwelling events. The sharp jump in the transformations around 0 meters/second usually is indicative of two regimes, consistent with the belief that changes in upwelling events are of much different import to the fish than changes in downwelling events.

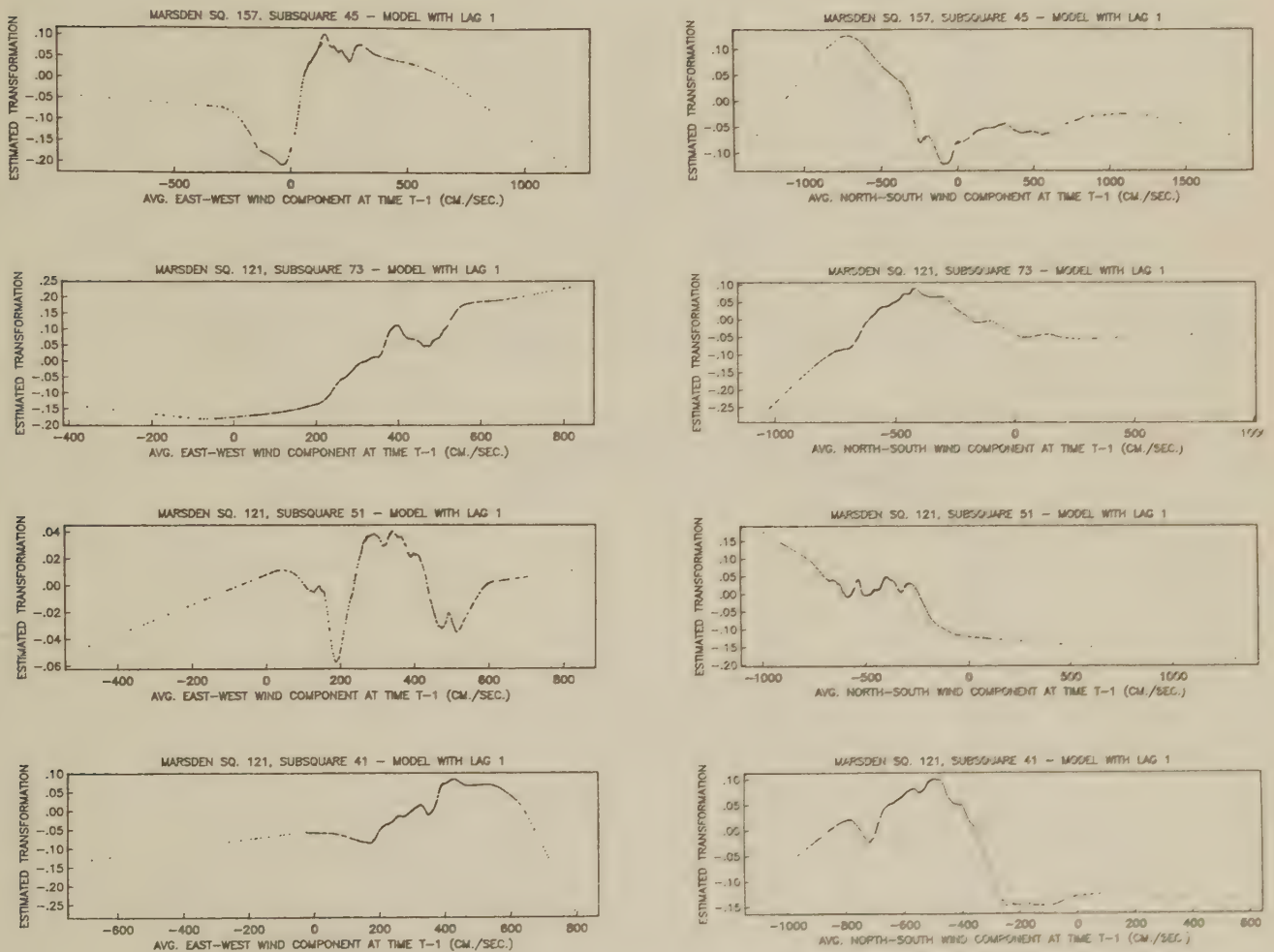


Figure 3. Plots of the estimated optimal transformation for the east-west component of the wind versus the original wind data. Figure 4. Plots of the estimated optimal transformation for the north-south component of the wind versus the original wind data at four areas.

To determine whether the transformations are meaningful, Mendelssohn and Husby ran the original data through an algorithm that estimates multivariate autoregressive models with missing data, and also produces estimates of the missing data. The estimated CPUE values (Figure 5) suggest high level of CPUE at times when it is unlikely that the fish are available to the jig fishery. However, when they ran the transformed data through the identical algorithm (Figure 6) they found sharply defined fishing seasons, much more consistent with observed fishing conditions. This suggests that the transformed relationships have gone a long way in defining the conditions in which one can expect high levels of CPUE for albacore.

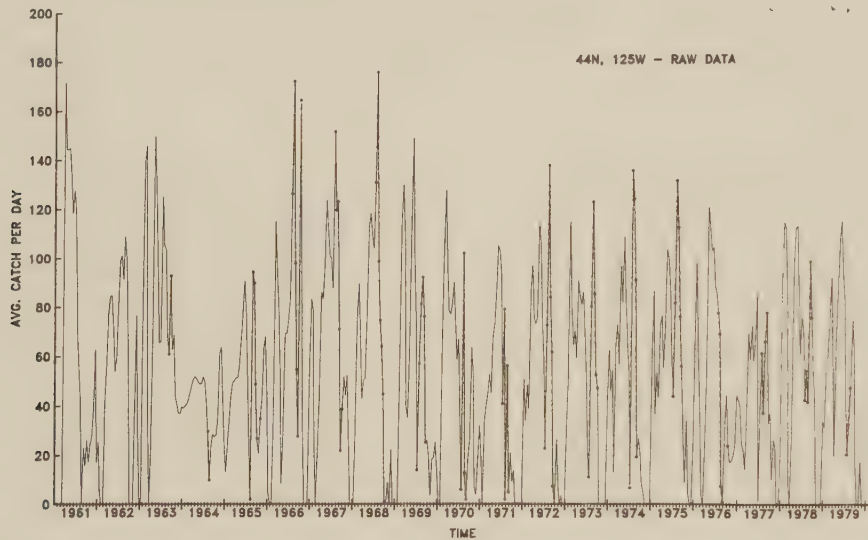


Figure 5. Original CPUE data (dashed line) versus estimates from fill-in model using raw data for all variables.

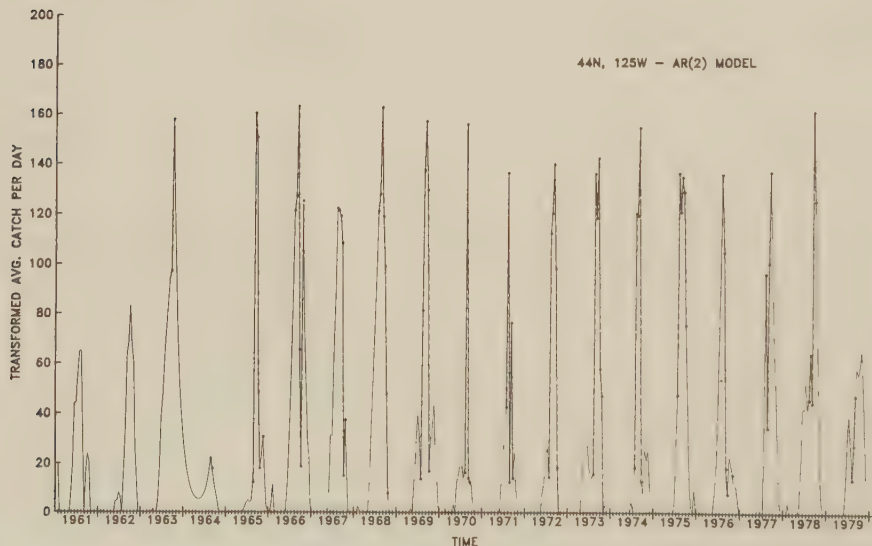


Figure 6. Transformed CPUE data (dashed line) versus estimates from fill-in model using raw data for all variables.

In sum, Mendelssohn and Husby have shown why they feel previous attempts at correlating tuna CPUE and environmental conditions have failed. The relationships between the environmental conditions and CPUE are highly nonlinear and occur at time scales that are different than the ones normally examined in such studies. The fact that their simple models that do not yet include spatial relationships (at time lags) and longer scale lags (i.e., seasonal effects) explain such a large part of the observed variance in CPUE makes them optimistic about the possibility of producing fine-scale forecasts of CPUE. (R. Mendelssohn (408) 646-3311)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

TUNA ASSESSMENT INVESTIGATIONS

Cooperative Striped Marlin Research Planned

Staff of the Tuna and Billfish Assessment Program and the California Department of Fish and Game (CDFG) have planned and are preparing to execute five cooperative research cruises designed to assess the diel behavior of striped marlin in the vicinity of the private and commercial fishing fleets. Fishery Biologists Norm Bartoo, David Holts and Earl Weber will accompany CDFG biologists on the week-long cruises scheduled from September through December on the chartered vessel Pacific Clipper.

Striped marlin will be tagged with sonic tags which communicate the location of the marlin as well as the depth at which the fish is swimming. The information gained will be used to estimate the vulnerability of marlin to various fishing gears used in the area during both night and day. Water temperature measurements made throughout the water column during the sonic tracking will be used to explain marlin movement and distribution. Several owners of private party boats and yachts have volunteered to catch and supply the marlin for the experiment.

The feasibility of diel sonic tracking of striped marlin in the California Bight was proven by the SWFC biologists in September 1982, when two marlin were tagged with ultrasonic transmitters; one was followed for 24 hours. Results from the first track indicated the marlin spent the majority of its time in the upper 30 feet with dives to greater depths. (N. Bartoo, FTS 893-6244)

ECOLOGICAL FISHERY SYSTEMS INVESTIGATIONS

Albacore Model Encompasses Large Set of Parameters

A model that simulates recruitment, growth, movement, natural mortality and harvest of albacore by three fishing fleets, the Japanese baitboat fleet, the Japanese longline fleet, and the United States jig fleet, has been implemented by Fishery Biologist Pierre Kleiber. The model begins with starting values of the population of fish at large and the disposition of those fish both geographically and by each fleet as a function of time and geographic area on the basis of a time series of effort

values by fleet and geographic area and a large set of parameters of recruitment, growth, movement, natural mortality, and harvest.

The purpose of the model was to provide a tool for evaluating the possible effects of various management actions on the fishery. It has not been used for this because no such actions have been proposed for the north Pacific albacore fisheries.

Instead, Kleiber used the model to investigate interaction between fishing fleets, an issue that can be of great concern to fishermen and fishery managers. The requirements of the model are similar to those of evaluating management actions. A typical year in the life of the fishery was produced by simulation over many years, with the input of constant recruitment and a constant seasonal pattern of fishing effort. Thus, the results were not dependent on precise starting values. The nominal catch of each of the fleets in the typical year was compared with catch when the effort in one of the fleets was either doubled or halved. The results are sensitive to the exploitation rate, which in the model was adjusted to be in line with results of albacore tagging that has been carried out for many years in the North Pacific by the American Fishermen's Research Foundation and Michael Laurs, Oceanographer in the Coastal Fisheries Resources Division.

The North Pacific albacore model has also been and may continue to be useful in a broader, heuristic sense. The modelling effort has served as a focus for planning of albacore research by illuminating gaps in what is known about albacore. In addition, plans are underway to use the model as a basis for developing two new methods of data analysis, both taking advantage of the built-in geographic structure and migration features of the model. One would be a geographically heterogeneous form of cohort analysis and the other would be a quantitative evaluation of migration from tagging data. (P. Kleiber, FTS 893-6294)

Bio-economic Model Designed for a Developing Fishery

In August, Dr. Pierre Kleiber, Fishery Biologist, taught the final 2 weeks of a 5-week course on fishery data processing with microcomputers. The course, which took place at Oregon State University, was sponsored by the Consortium for International Fisheries and Aquaculture Development. Attending the course were fishery officers from Morocco, Grenada, and Mexico.

During the course, Kleiber and his students did several modelling exercises. One of the exercises produced results pertinent to stock assessment work carried out at the Southwest Fisheries Center and other fisheries agencies.

Figure 1 shows a plot of catch against effort from a simple model of a logistic population supporting a developing fishery that starts with a small amount of effort on a virgin population. In subsequent time periods, the effort in the fishery is augmented (or decremented) according to the amount of profit (or loss) in the preceding time period. Profit is determined by the difference between the actual catch per effort and a break-even catch per effort level at which the value of the fish caught just equals the cost of deploying the effort to catch it. The straight line in the figure separates the profitable region (above the line) from the region of loss (below the line). The slope of the line is the break-even catch per effort.

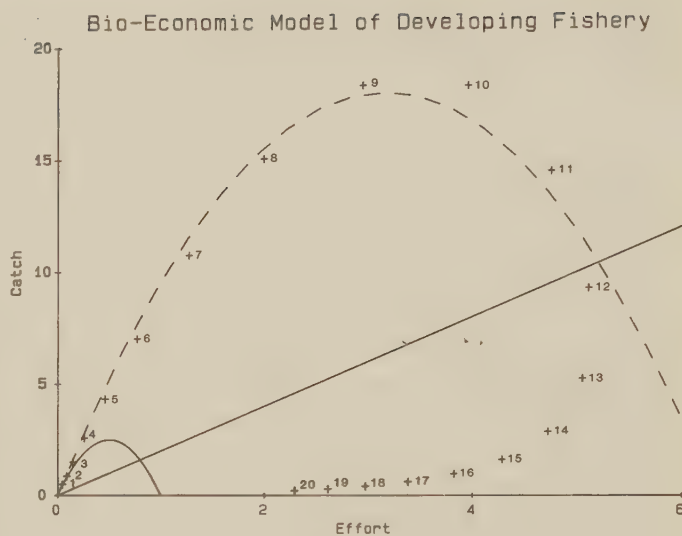


Figure 1

The points in Figure 1 are the yearly catch and effort values from the model. Data such as these are very commonly analyzed with the production model, and many methods of fitting the production model (the popular program PRODFIT for example) assume that the population is always in equilibrium. The solid parabola in the figure is the real equilibrium yield curve for the population in the model. The top of that curve indicates that the maximum catch that the population can sustain indefinitely (MSY) is 2.5, and 0.5 is the corresponding optimum effort.

Normally, the equilibrium yield curve is not known. Biologists try to deduce it by fitting the production model to the points in the figure. The students were asked to imagine a scenario in which after the twelfth year of the fishery (the first year of net loss) a biologist is asked to calculate the maximum sustainable yield and optimum effort for the fishery. Using an equilibrium method this biologist will get something close to the dashed parabola in Figure 1. PRODFIT with the equilibrium assumption gives an estimate of 17.1 for MSY and 3.2 for the optimum effort. If fishery managers were to follow the biologist's advice and fix effort at 3.2, the fishery would still be highly overfished and would collapse. These results are essentially a "fishing up" phenomenon, a concept that is certainly not unknown to fishery science. However, the implications are important enough that it is useful for those in the stock assessment business to be reminded of them from time to time. (P. Kleiber, FTS 893-6294)

TIBURON LABORATORY

Tiburon, California

Groundfish Coordination Meeting Held

A meeting to coordinate NMFS research on West Coast groundfish was held at the Tiburon Laboratory August 7 and 8. Attending the meeting were included Tom Dark, Richard Marasco, and Gary Stauffer of the Northwest and Alaska Fisheries Center, John Hunter, Daniel Huppert, and Richard Methot of the Southwest Fisheries Center, Jerrold Norton of the Pacific Fisheries Environmental Group, and Peter Adams, Edmund Hobson, Susumu Kato, William Lenarz, Susan Smith, Jeannette Whipple, and Norman Abramson of the Tiburon Laboratory. During the meeting, the participants discussed research objectives and existing cooperative activities, and they discussed areas in which future joint planning and operations would be productive. The participants agreed that sablefish research appeared to be promising for combined research efforts. A subcommittee of the participants was assigned the task of producing an operational plan for stock assessment in the near future. (N. Abramson, FTS 556-0565)

GROUNDFISH ANALYSIS INVESTIGATION

Relatively Strong Year Class of Bocaccio Entering the Fishery

Bocaccio (Sebastes paucispinis) is usually the second or most important species of rockfish in California trawl landings. Until recently, dynamics of the stock were poorly understood. Some aspects of the dynamics are now becoming clear from studies by staff members of the California Department of Fish and Game (CFG) and the Groundfish Analysis Investigation of the Tiburon Laboratory. One aspect is that California landings tend to be dominated by a single year class. A report by David Thomas of the CFG Menlo Park Laboratory showed that landings between 1979 and 1984 were dominated by the 1977 year class. This year class contributed about 50% of the landings in 1981 and still contributed about 30% of the landings in 1984.

Another significant year class appears to be entering the fishery. Data from the NMFS Marine Recreational Fishery Statistics Survey show that a relatively strong year class began entering the California recreational fishery in 1984 (Figure 1). Data collected during the cooperative CFG and NMFS commercial port-sampling program indicate that this year class began entering the Monterey trawl fishery in 1985 and appears to be the strongest to enter the fishery since 1977 (Figure 2). Preliminary aging of otoliths collected in 1985 indicates that

the 1984 year class is the predominant year class. As part of the Tiburon Laboratory's studies on rockfish recruitment, the Groundfish Analysis Investigation has been conducting midwater trawl surveys from the NOAA Ship David Starr Jordan to estimate the abundance of juvenile rockfish off central California. The results indicate that during the 1983-1986 period juvenile bocaccio were the most abundant rockfish in 1984. According to Fishery Biologist Tina Wyllie Echeverria, the index of abundance of juvenile rockfish calculated from midwater trawl surveys off central California was 0.0 for 1983, 1.3 for 1984, 0.2 for 1985, and 0.8 for 1986.

There are insufficient data to provide an estimate of the absolute abundance of the 1984 year class. The fishery data are difficult to interpret because it is not known to what degree the Monterey fishermen targeted on the 1984 year class, compared with the effort expended on the 1977 year class when it entered the fishery. Cohort analysis of data collected from the entire fishery will provide an estimate of the strength of the year-class in several years. Although the midwater trawl survey for juveniles provides more quantitative data at this time and is designed to produce estimates of year-class strength, it will be necessary to correlate a number of survey estimates with fishery-derived estimates of year-class strength before it will be possible to estimate absolute year-class strength from the survey data. Eventually the estimates will provide a valuable tool for projecting future stock conditions for bocaccio and other

PROPORTION

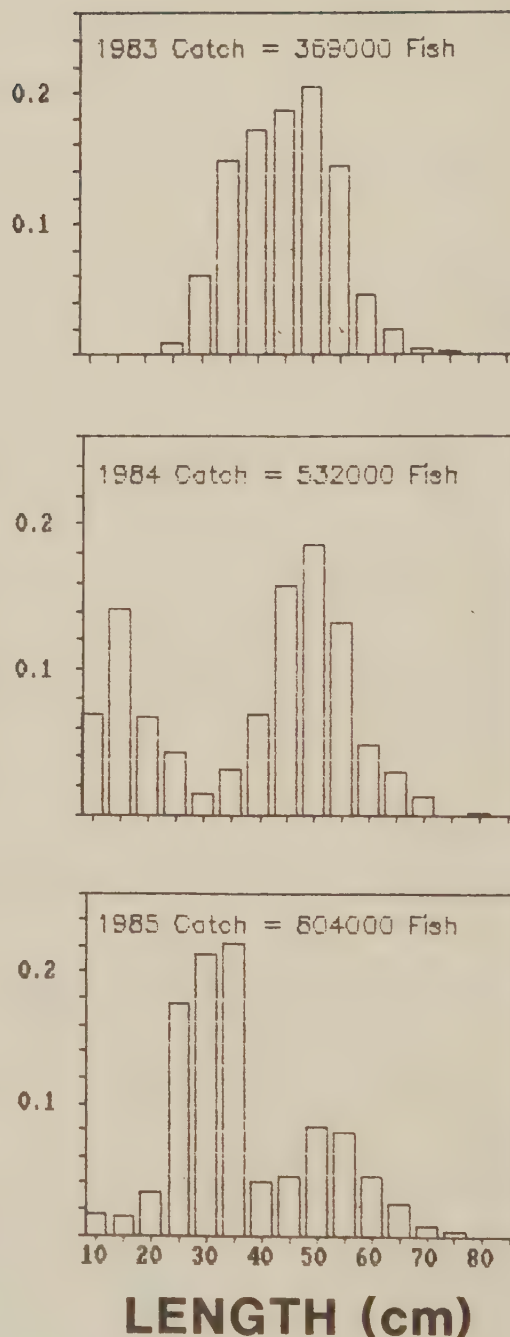


Figure 1. Length frequencies of recreationally - caught bocaccio, 1983-1985. Source: Current Fishery Statistics, Numbers 8325 and 8328.

important species of rockfish. The improved projections will reduce the uncertainty in management of these valuable fisheries. (W. Lenarz, FTS 556-0565)

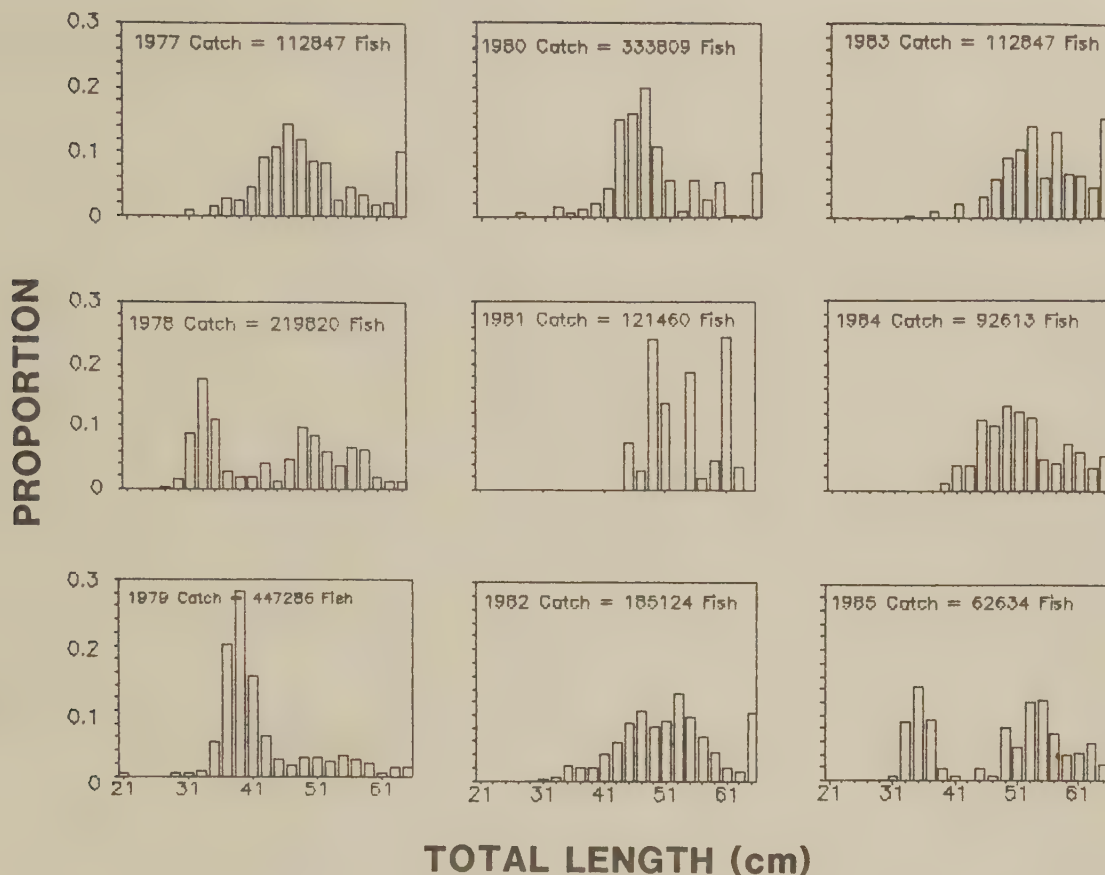


Figure 2. Length frequencies of trawl bocaccio landings in Monterey, 1977-1985. Source: California Department of Fish and Game and NMFS cooperative rockfish port-sampling program.

Range of Eelpout Extended

Carol Reilly, Biological Technician with the Groundfish Analysis Investigation, met with Eric Anderson, ichthyologist with the California Academy of Sciences, to determine the species of eelpouts captured during the June 1986 midwater trawl survey. Anderson confirmed the identification of three eelpouts to be Lycodapus mandibularis and tentatively identified the fourth, caught in Monterey Bay, as Lycodapus parviceps. This species has previously been reported only as far south as British Columbia. (T. Wyllie Echeverria, FTS 556-0568)

GROUNDFISH COMMUNITIES INVESTIGATION

Age Validation Study of Lingcod Initiated

To validate the use of dorsal fin rays to age lingcod (*Ophiodon elongatus*), Fishery Biologists Peter Adams and Susan Smith and Biological Aid Wayne Samiere have begun a study of tetracycline-tagged fish.

There have been substantial changes in the pattern of landings of lingcod along the Pacific Coast during 1984 and 1985. Landings of lingcod have nearly doubled in the Vancouver area, although they have declined substantially in the Eureka, Monterey, and Conception areas. The importance of these changes in landings is difficult to evaluate since lingcod landings are not monitored for age composition. They are not monitored because the otoliths of this species are especially difficult to age. The use of dorsal fin rays to age the fish has proven to be a practical alternative because the dorsal fin rays can be removed without destroying the fish, so large numbers can be processed in catch sampling. The problem is that in using the dorsal fin rays to age the fish, Adams has found that for fish smaller than 50 cm the growth rates are slower than expected. For that reason, Adams, Smith and Samiere have begun the study of tetracycline-tagged fish to validate the use of dorsal fin rays as an aging technique. They have injected three lingcod, which are being maintained in the laboratory at Bodega Bay. (P. Adams, FTS 556-0565)

GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

Northern Rockfish Compared to Local Population

Brian Jarvis, Biological Technician, participated in the first leg of the Northwest and Alaska Fisheries Center triennial groundfish trawl survey on the University of Washington research vessel Alaska from Coos Bay, Oregon, to Westport, Washington, August 2-20. He was able to collect 22 yellowtail rockfish and 5 bocaccio for comparison with the Cordell Bank rockfish population currently under study by staff of the Groundfish Physiological Ecology Investigation. The yellowtail rockfish appeared to be well fed and in good health, with plenty of mesenteric fat. Male gonads were beginning to mature and ovaries were either in a resting phase or beginning to mature. The same parasites found in fish from Cordell Bank were present, but in fewer numbers. (B. Jarvis, FTS 556-0565)

FISHERIES INFORMATION SYSTEMS & ADP

Program Acquired to Transfer Files on the 32X Local Area Network

A multi-featured communications program named PROCOMM has been acquired by ADP Operations. The program enables file transfers between the Center's Molecular 32X super microcomputer and IBM/IBM compatible PCs. Consent has been given by the developers of PROCOMM for the program to be copied and distributed at no cost to interested users within the Center. File transfers may be conducted at 9600 Baud on the 32X local area network (LAN) using the XMODEM protocol. Since files may be efficiently transferred between the UCSD VAX and the 32X using nine track magnetic tape, this recent development completes a convenient and inexpensive path for moving large amounts of data from the VAX, across the 32X, to individually maintained PCs. Although many VAX job applications are too large to be run on PCs, this simplifies the downloading of appropriate work and provides an alternative for more economical computing. (D. Roll, FTS 893-6250)

Southwest Region to Assume PACFIN Data Base Management

Gerry Hornof, Computer Specialist, Southwest Region, and Svein Fougner and Chuck Korson of the Southwest Region's Fisheries Management and Analysis Branch, met with John Carr, Dan Huppert, Susan Jacobson, and Dorothy Roll to discuss the transfer of responsibility for managing the Pacific Fishery Information Network (PACFIN) data bases. These data bases were designed and previously compiled and maintained at the SWFC under the direction of Dan Huppert. The system includes routines for processing data and user documentation. The data bases contain information on commercial fish landings and registered vessels for California, Oregon, and Washington for the years 1981 through 1984. Chuck Korson will become the manager for the PacFIN data base following updating the system with 1985 data. (D. Roll, FTS 893-6250)

MISCELLANEOUS

PUBLIC AFFAIRS

Honolulu Laboratory

Honolulu Laboratory Employee Wins Gold and Bronze Medals in International Competition for Disabled Athletes

Jeffrey D. Sampaga, Biological Aid at the Honolulu Laboratory, won two gold medals for the shotput and one bronze medal for the javelin at the International Stoke Mandeville Games from July 26 to August 3 at Aylesburg, Buckinghamshire, England. Sampaga was one of 800 disabled athletes representing 36 countries.



Gold-medal winner
Jeffrey D. Sampaga

The International Stoke Mandeville Games are a competition for disabled athletes from throughout the world. It is held annually in England. To qualify for competition in England, Sampaga competed in the Aloha Regional Games for the Disabled in Honolulu, Hawaii. He then qualified to compete in the National Wheelchair Games at Erie, Pennsylvania in 1985, where he won gold medals in the discus and javelin events and a silver medal in the shotput.

Based on his accomplishments in the national games, Sampaga was selected for the U.S. team to compete in the international games. The U.S. team was composed of over 50 disabled athletes including those who competed in men's and women's basketball.

Sampaga was one of four wheelchair athletes in the U.S. field event team. Although he did not set any new records in any of the events, he still holds the world record in the discus (29.14 meters) for wheelchair athletes. Sampaga is probably the only NOAA employee to hold a world record in a wheelchair track and field event.

PRESS RELEASES

Honolulu Laboratory

July 14 - Cooperative Effort to Save Endangered Species.

La Jolla Laboratory

July 24 - Fisheries Service Begins 5-year Program to Measure Abundance of Dolphins in Eastern Pacific.

SEMINARS

Honolulu Laboratory

July 25 - Dr. R. W. Gauldie, Ministry of Agriculture and Fisheries, Fisheries Research Centre, Wellington, New Zealand, spoke on "Taking Stock of Fisheries Genetics/Developing a Theory of Otolith Growth."

August 8 - Timothy C. Tricas, Department of Zoology, University of Hawaii, spoke on "Seasonal Patterns of Growth and Reproduction in Coral-Feeding Kikakapu."

15 - Dr. George Ettershank, Professor of Biology, Monash University, Victoria, Australia, spoke on "Studies on Age Structure in Antarctic Krill - A Synthesis of Methods."

La Jolla Laboratory

July 15 - Dr. Paul W. Sammarco, Australian Institute of Marine Science, Queensland, Australia, presented "The Helix Experiment: Determination of Larval Dispersal Patterns in Corals."

22 - Dr. Robert Gauldie, Fisheries Research Division, New Zealand Ministry of Agriculture and Fisheries, Wellington, New Zealand, gave a seminar on "Otolith Ion Content and Ambient Temperature."

30 - Dr. Derek Staples, Commonwealth Scientific and Industrial Research Organization, Marine Laboratories, Cleveland, Australia, presented "Penaeid Prawn Recruitment Research of the CSIRO Marine Laboratories, Cleveland, Australia."

- August 14 - Randall M. Peterman, Natural Resource Management Program, Simon Fraser University, Vancouver, British Columbia, Canada, and National Research Council Fellow at the Southwest Fisheries Center, presented a seminar on "Sources of Variation in Mortality and Recruitment of Northern Anchovy, Engraulis mordax."
- 26 - Ms. Karen Marti, Department of Experimental Statistics and Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island, presented a seminar on "Fitting Two Regression Lines to Data."

Pacific Fisheries Environmental Group

- August 1 - PFEG and Hopkins Marine Station co-sponsored a seminar at Hopkins Marine Station called "Penaeid prawn recruitment research of the CSIRO Marine Laboratory" given by Dr. Derek Staples, CSIRO Marine Laboratories, Cleveland, Australia.

Tiburon Laboratory

- July 16 - Tony Chess, NMFS Tiburon Laboratory, spoke on "Trophic relationships in the shortbelly rockfish (Sebastes jordani)," as part of the Tiburon Seminar Series, a cooperative effort of the Paul F. Romberg Tiburon Center for Environmental Studies (San Francisco State University) and the Tiburon Laboratory.
- August 20 - Dr. Bruce MacFarlane, NMFS Tiburon Laboratory, spoke on "Stress evaluation in fish," as part of the Tiburon Seminar Series, a cooperative effort of the Paul F. Romberg Tiburon Center for Environmental Studies (San Francisco State University) and the Tiburon Laboratory.
- 27 - Dr. Larry Breaker, Physical Oceanographer and Visiting Scientist, Moss Landing Marine Laboratory, spoke on "Observations on interannual and short-term variability in the California Current system," as part of the Tiburon Seminar Series, a cooperative effort of the Paul F. Romberg Tiburon Center for Environmental Studies (San Francisco State University) and the Tiburon Laboratory.

HONORS AND AWARDS

Honolulu Laboratory

Honolulu Laboratory Employee Completes Forty-Five Years of Federal Service

Melvin J. Dutro, Sr., Clerk (Office Machine Operator), in the Honolulu Laboratory's Administration Section, completed 45 years of federal service on August 12, 1986.

Dutro was born in Watsonville, California, and lived there until he was 18 years old. On October 4, 1939, he enlisted in the U.S. Army and was first stationed in Hawaii at Schofield Barracks. He is a World War II combat veteran of the Pacific war in New Guinea and earned the Combat Infantryman's Badge of which he is justifiably proud. He was honorably discharged from the Army on August 29, 1945, and immediately took a job as a civilian employee at the motor pool operated by the Corps of Engineers at Schofield Barracks. For about 8 years between 1945 and 1953, including a short period when he tried a job in the private sector, Dutro held various jobs in the federal service working for the military in Hawaii. He joined the Southwest Fisheries Center Honolulu Laboratory (which was then known as the Pacific Oceanic Fishery Investigations under the Fish and Wildlife Service in the Department of the Interior) on March 15, 1953, and has worked continuously at the Laboratory where he has now completed a total of 45 years of federal service.



Melvin J. Dutro, Sr.

During a special assembly of employees at the Honolulu Laboratory, Dutro was recognized for his signal achievement. Shomura presented Dutro with a special 45-year service pin and read the accompanying congratulatory letter from William G. Gordon, Assistant Administrator for Fisheries, National Marine Fisheries Service, which stated in part, "On behalf of the National Marine Fisheries Service, I am pleased to extend congratulations and best wishes on the occasion of your

completion of 45 years of federal service on August 12, 1986. This is an outstanding record which should be a source of pride to you and an example to your co-workers at the Honolulu Laboratory." In addition to the service pin and congratulatory messages, Dutro was presented with a special gift and Hawaiian leis from his fellow employees. Said Dutro, who was visibly affected by the proceedings, "I'm really proud to earn this 45-year pin. It was one of my really important goals in life."

Dutro is the father of 1 daughter, 2 sons, and in addition has 2 stepsons, 14 grandchildren, and 3 great grandchildren. When asked about his plans for retirement, Dutro replied that he hoped to work for at least 2 more years. Perhaps deep in his heart, Mel Dutro's goal is to earn a 50-year service pin.

* * * * *

July 29 - Laboratory Director Richard S. Shomura presented a 10-year length of service pin to John R. Henderson. Receiving awards for Outstanding Performance were: David C. Hamm, Ray F. Sumida and Elizabeth F. Y. Young. Receiving awards for Sustained Superior Performance: Joseph T. Arakawa, Melvin J. Dutro, Sr., Robert G. Forsyth, Fred R. Frizelle, III, Wayde S. Higuchi, Wesley K. Higuchi, Robert L. Humphreys, Jr., Thea C. Johanos-Kam, Todd T. Kassman, Sally H. Kuba, Dorothy D. Powell, Michael P. Seki, Robin L. Westlake, and Happy A. Williams. Receiving Special Act or Service awards: Alan R. Everson, Carol M. Fujisawa, Virginia L. Ishida, Louise F. Lembeck, Bruce C. Mundy, Fletcher V. Riggs, Kathleen M. Repollo, David A. Somerton, and Carole A. Yukihiro.

La Jolla Laboratory

During ceremonies at the La Jolla Laboratory on July 24, 1986, Director Barrett presented awards to staff members for Special Act (SA), Sustained Superior Performance (SSP), or Quality Step Increase (QSI).

Pictured below are: (back row) Carol Kimbrell (SSP), Steve Ackroyd (SA), Ken Wallace (SSP), Charles Oliver (SSP), Clifford Ratcliffe (SSP), Steve Reilly (SA), David Holts (SSP), Rob Bistodeau (QSI), Al Jackson (SSP), Al Coan (SSP); (front row) Gail Theilacker (SSP), Cindy Meyer (SSP), Bill Flerx (SA), Barbara MacCall (SSP), Elaine Acuna (SSP), Ruth Miller (SSP), Hannah Bernard (SA), Celeste Methot (SSP), Susan Chivers (SSP), Aaron Weinfield (SSP), Ron Dotson (QSI), Rich Charter (SSP), Nancy LaRoche (SSP), David Ambrose (SSP); (not shown) David Au (QSI), Aleta Hohn (QSI), Virginia Hostler (QSI), Mark

Lowry (SSP), Ken Raymond (QSI), Randy Rasmussen (SA), Elizabeth Stevens (SSP), Julie Shoemaker (SSP), Jerry Hornof (QSI), and Nancy Lo (SSP).



Albert Myrick (left) received Length of Service Award for 20 years and John Carr received Length of Service Award for 30 years of federal service.



Tiburon Laboratory

Norman Abramson presented Sustained Superior Performance Awards to Dan Howard, Maureen Leet, Bruce MacFarlane, Wayne Samiere, and Ed Ueber.

VISITORS

Honolulu Laboratory

- July 10 - Henry Sakuda met with Richard Shomura to discuss preparation of two papers for the FAO meeting on Expert Consultation on Inland Fisheries of Indo-Pacific Islands held in Bangkok (instead of Honolulu), August 4-8, 1986.
- Lou Eldredge of the University of Guam Marine Laboratory visited Richard Shomura.
- 21 - Robert Gillett, Fisheries Development Adviser, South Pacific Regional Fisheries Development Programme, UN Development Programme, FAO, Suva, Fiji visited Richard Shomura.
- 31 - Dr. T. Suzuki of Hokkaido University paid a courtesy call to Richard Shomura. Dr. Suzuki was in Honolulu for a University of Hawaii-Hokkaido University cooperative squid research program.
- August 19 - Robert W. Knecht and Bilitiana Cicin-Sain of the University of California, Santa Barbara, met with Richard Shomura to obtain information on 200-mile EEZ activities in the South Pacific.
- 25 - Michael Dahlberg and Michael Sigler of the Auke Bay Laboratory visited Richard Shomura when the Hai Kung made a resupply stop in Hawaii during a squid research cruise.
- 27 - Mary Lou Drake of Western Administrative Support Center visited Richard Shomura.

La Jolla Laboratory

- July 7 - K. R. McCloy, Department of Agriculture, New South Wales, Australia, met with Reuben Lasker.
- 15 - Hassen Akrouit, Director of the National Fisheries Office, Tunis, Tunisia, met with Izadore Barrett.

- July 28 - Hans Hansen, Office of the Inspector General,
August 1 Department of Commerce, was at the Center.
- 19-20 - NMFS representatives from Washington, D.C.,
Seattle, Woods Hole, Miami, and Terminal Island
came to the Center to attend the Research Council
Meeting.

Pacific Fisheries Environmental Group

- July 2 - Andy Bakun met with Daniel Pauly, International
Center for Living Aquatic Resources Management,
Philippines.
- August 1 - Derek Staples, CSIRO Marine Laboratories,
Cleveland, Australia visited PFEG for general
discussions with various staff members.
- 6- 7 - David Ventresca, California Department of Fish and
Game, visited PFEG to receive help from PFEG staff
on graphics and to discuss fishery data bases with
Linda Garrett, Biological Aide.
- 14-15 - Hans Hansen of the San Francisco office of the
Inspector General visited PFEG.
- 27 - Paul Spizzirri, WASC Procurement Division, visited
PFEG.

Tiburon Laboratory

- July 9 - Norman Abramson and Edward Ueber met with Hassen
Akrouit, Director of the National Fisheries Office
of Tunisia. Akrouit was interested in discussing
methods used for stock assessment, in learning
about fishery management and enforcement
procedures used on the Pacific Coast, and of
locating possible market outlets for Tunisian
fishery products.

MEETINGS AND TRAVEL

Honolulu Laboratory

- July 14 - A special half-day briefing on the Honolulu
Laboratory's research program was given to Kitty
Simonds of the Western Pacific Regional Fishery
Management Council, Rose Pfund of the University
of Hawaii Sea Grant College Program, Alan
Marmelstein of the U.S. Fish and Wildlife Service,

Henry Sakuda and Al Katekaru, Hawaii Division of Aquatic Resources, and Doyle E. Gates, John J. Naughton, and Peter A. Milone, Western Pacific Program Office, Southwest Region. Boehlert and Jerry A. Wetherall, and William G. Gilmartin and Sam Pooley made presentations on their research programs.

- 15-16 - A cooperative (NMFS-Republic of Korea) squid workshop was held in the Honolulu Laboratory conference room. Participants included the Northwest and Alaska Fisheries Center staff and from the Fisheries Research and Development Agency, Pusan, Korea, Yeong Chull Park, Yeong Seung Kim, and Jung Ku Kang. A species identification training session was held for the visitors on July 17-18 in the conference room.

July 16 - George Boehlert traveled to Japan and the Soviet Union. In Japan he visited the Far Seas Fisheries Research Laboratory, Hokkaido University, and the Japan Sea Regional Fisheries Research Laboratory, and in the Soviet Union he attended the First Pacific Symposium on Marine Sciences.

August 1-12 - Laboratory Director Richard S. Shomura accompanied J. R. Spradley, Special Assistant to NOAA Administrator Anthony Calio, on a trip to the South Pacific. Spradley and Shomura made presentations on a proposed South Pacific NOAA initiative at the 18th Regional Technical Meeting on Fisheries, South Pacific Commission, Noumea, New Caledonia, and met with officials of the Committee for Coordination of Joint Prospecting for Mineral Resources in the South Pacific Offshore Areas, and the Embassies of Australia and New Zealand during a visit to Suva, Fiji.

La Jolla Laboratory

July 2 - SWFC and SWR economists met in La Jolla to review research in progress.

7- 9 - Director Barrett attended the Pacific Council's Scientific and Statistical Committee meeting in Portland, Oregon.

7- 9 - Richard Methot traveled to Portland, Oregon, to present the anchovy biomass estimate to the Pacific Fisheries Management Council.

7-10 - James Squire went to Los Cabos, Mexico, to make the annual Gardiner Foundation Award and to contact the owners of other fishery resorts in the

area to discuss the tagging program and distribute tagging equipment for 1987.

- 8-11 - Mark Lowry and Jeanne Wexler censused sea lion pups and collected sea lion scats at Santa Barbara Island.
- 10 - A program review of the Fishery Marine Mammal Interactions Division was held.
- 10 - John Hunter, Reuben Lasker, Nancy Lo, Alec MacCall, Richard Methot, and Paul Smith met with biologists from the California Department of Fish and Game for a workshop on monitoring and management of the Pacific sardine.
- 11 - Members of the Southwest Region, Southwest Fisheries Center, Marine Mammal Commission, and the tuna industry met to discuss the porpoise quota.
- 14-15 - Daniel Huppert traveled to San Francisco to attend the final joint meeting of the working group on Limited Access to Pacific Groundfish.
- 16-17 - Richard Methot went to Los Angeles to review the potential impact of seismic oil exploration on fish eggs and larvae.
- 16-17 - Paul Smith traveled to Los Angeles to attend a workshop on the CalVET and to serve on a Seismic Technical Review Panel.
- 20-31 - Michael Laurs went to Portland, Oregon, to work with scientists at Oregon State University on satellite remote sensing and juvenile salmon research. He also went to Corvallis, Oregon, to attend the American Fisheries Society, Western Division, meeting.
- 21-25 - A training session was held for dolphin observers.
- 23-25 - Jay Barlow met with Mexican researchers in Guaymas, Mexico, to discuss development of a *Phocoena sinus* recovery plan.
- 24-31 - Mark Lowry censused California sea lion pups at San Miguel Island.
- 25-28 - Charles Oliver went to San Clemente Island to obtain peak pup counts of California sea lions.
- July 29 - Steve Reilly went to sea aboard the NOAA Ship
August 28 McArthur to join the survey of dolphins in the eastern tropical Pacific as cruise leader.

- Andy Dizon went to sea aboard the NOAA Ship David Starr Jordan to join the survey of dolphins in the Pacific.

July 29 - Rennie Holt joined the survey of dolphins in the
October 2 Pacific as cruise leader.

- 29 - James Squire traveled to Torrance and Santa Barbara to contact aerial monitoring contractors and obtain and review flight logs. He also went to Santa Catalina Island to distribute tagging supplies for the 1986 season.

July 29 - Pierre Kleiber went to Corvallis, Oregon, to teach
August 29 part of a course on fishery data processing for fishery officers from developing countries.

August 4 - Izadore Barrett traveled to Davis, California, to meet with University of California Davis Vice Chancellor.

6- 8 - Daniel Huppert, John Hunter, and Richard Methot attended a meeting of NMFS West Coast Groundfish Research Committee at Tiburon, California.

6- 9 - Izadore Barrett participated in the 54th meeting of the Western Pacific Fishery Management Council in Kailua-Kona, Hawaii.

8-11 - Mark Lowry and Jeanne Wexler tagged California sea lion pups at San Nicolas Island.

8-15 - Wayne Perryman traveled to Santa Barbara Island to make initial sea lion and fur seal assessment counts.

10-17 - Elizabeth Vetter traveled to Syracuse, New York, to review potential methods for analysis of tuna vessel observer data.

12-13 - Cynthia Thomson participated in the Marine Recreational Fisheries Task Force meeting in La Jolla.

19-20 - Attending a Research Council Meeting were (see photo below, from left to right) Dr. Richard J. Berry, Director, Southeast Fisheries Center, Miami, Florida; Dr. William Aron, Director, Northwest and Alaska Fisheries Center, Seattle, Washington; Mr. Richard V. Cano, Acting Director, Office of Utilization Research, Washington, D.C.; Dr. Joseph W. Angelovic, Deputy Assistant Administrator for Science and Technology, Washington, D.C.; Dr. Hoyt A. Wheeland, Director,

Office of Data and Information Management, Washington, D.C.; Mr. Allen E. Peterson, Jr., Director, Northeast Fisheries Center, Woods Hole, Massachusetts; Dr. Izadore Barrett, Director, Southwest Fisheries Center, La Jolla, California; Mr. David Rand, Deputy to Deputy Assistant Administrator for Science and Technology, Washington, D.C.; Mr. George Knobl, Director, Office of Resource Investigations, Washington, D.C.



- August 25 - Wes Parks joined the survey of dolphins as cruise
November 6 leader aboard the David Starr Jordan.
- August 28 - Al Jackson traveled to Lima, Peru, to board the
December 10 McArthur to join the survey of dolphins in the Pacific Ocean as a member of the scientific crew and cruise leader.

Pacific Fisheries Environmental Group

- July 2- 6 - Andy Bakun and Paul Sund attended the Special Symposium on Life History, Systematics, and Zoogeography of Cephalopods held in conjunction with the 52nd Annual Meeting of the American Malacological Society in Monterey. Bakun participated in discussions of a proposed International Squid Recruitment Project under the Ocean Science and Living Resources Program
- August 5 - NOAA Corps Officer Rusty Brainard left for 6 weeks on the NOAA Ship Townsend Cromwell.

- 6- 8 - Jerry Norton traveled to Tiburon to attend the meeting on NMFS West Coast Groundfish Research Coordination.

Tiburon Laboratory

- July 2 - Norman Abramson met with Wally Clark of the Bodega Marine Laboratory, Chris Dewees of the University of California Marine Advisory Service, and Lindy Nagata and Rosemary Amidei of the University of California Sea Grant, as a Task Force charged with focusing some California Sea Grant research on rockfish problems. A September workshop was planned where academic researchers can discuss possible rockfish research proposals with each other and with NMFS and California Department of Fish and Game personnel; the meeting is scheduled to be held at San Francisco State University.
- 9-10 - Sus Kato and Bill Leet traveled to Red Bluff, California, to test night-fishing methods for catching squawfish.
- 15 - Norman Abramson and Bill Lenarz attended a meeting of the Economists Working Group and the Groundfish Alternative Management group at San Francisco State University.

PERSONNEL ACTIONS

Honolulu Laboratory

- July 4 - Robert J. Marrow, Wildlife Biologist - Resignation.
- 7 - Russell Y. Ito, Biological Technician (Fisheries) - Termination of Appointment.
- 19 - Todd T. Kassman, Computer Programmer - Resignation.
- 25 - Fletcher V. Riggs, Supervisory Programmer Analyst - Resignation.
- August 1 - Alice-May Drury, Secretary (Steno) - Optional Retirement.
- Jill Pennington-Soares, Clerk-Typist - Resignation.

- 3 - Hugh J. Beemer, Computer Clerk - Part-Time Temporary Appointment.
- 17 - John A. Loux, Biological Aid - Conversion to Part-Time, On-Call Appointment.
- Bernadette B. Soares, Clerk-Typist - Full-Time Temporary Appointment.
- 25 - Russell Y. Ito, Biological Technician (Fisheries) - Part-Time Temporary Appointment.
- 30 - Kathleen M. Repollo, Clerk-Typist - Termination of Appointment.

La Jolla Laboratory

- July 21 - Scott Benson, Biological Technician - Entered on Duty.
- Carla Bisbee, Biological Technician - Entered on Duty.
- Kurt Brownell, Biological Technician - Entered on Duty.
- William Irwin, Biological Technician - Entered on Duty.
- Richard LeDuc, Biological Technician - Entered on Duty.
- Michael Newcomer, Biological Technician - Entered on Duty.
- Robert Pitman, Biological Technician - Entered on Duty.
- Lawrence Robertson, Biological Technician - Entered on Duty.
- Michael Sinclair, Biological Technician - Entered on Duty.
- David Skordal, Biological Technician - Entered on Duty.
- Bernie Tershy, Biological Technician - Entered on Duty.
- Marc Webber, Biological Technician - Entered on Duty.

August 22 - Victoria Thayer, Biological Technician - Entered on Duty.

Tiburon Laboratory

July 3 - Turley Wond, Statistician - Resignation.

6 - Sennen Salapare, Fishery Biologist - Transfer to Office of Industry Services in Washington, D.C.

15 - Candis Cooperrider, Fishery Biologist - Resignation.

20 - David Woodbury, Biological Technician - Promotion.

August 3 - Joseph Hightower, Fishery Biologist - Promotion.

15 - Norma Smith, Clerk-Typist - Resignation.

17 - Elaine Mavrantonis, Clerk-Typist - Conversion to Part-Time Permanent.

Programs Provide Students with Summer Jobs

During July and early August the La Jolla Laboratory hosted two student groups providing scientific help and support to research programs at the Center. The first, the San Diego Regional Youth Employment Program, provided four high school students for an 8-week period. The students worked with researchers, programmers, and data managers assisting in the drive to update and correct computer data files. The students worked an average of 32 hours each week. This is the 12th year of Center participation in this program.

The second group of students worked under the Harvey Mudd College Upward Bound Program. This program provides low income students from the Los Angeles area with a combination of work in scientific and/or research agencies and academic study in a neutral environment. These students are chosen by the Harvey Mudd College staff based on their interest in science and their application of talent to do well in school. The Center has participated in this program for 14 years.

Both programs are enthusiastically supported, offering the students the opportunity to assist professionals in areas of interest to the student while providing researchers with work that would not otherwise be done.

Tiburon Laboratory

July 31 - Michael Bowers (Fishery Biologist), Maxwell Eldridge (Fishery Biologist), Rahel Fischer (Secretary), Walburga Giguere (Administrative Officer), Joseph Hightower (Fishery Biologist), Jeanne Hurst (Administrative Clerk), Bruce MacFarlane (Fishery Biologist), Sus Kato (Fishery Biologist), William Lenarz (Fishery Biologist), Edward Ueber (Industry Economist), and Jeannette Whipple (Fishery Biologist) - Stress Management Seminar, Career Track, Inc.

STATUS OF PUBLICATIONS

Published

Abe, H., R. W. Brill, and P. W. Hochachka. 1986. Metabolism of L-histidine, carnosine, and anserine in skipjack tuna. *Physiol. Zool.* 59:439-450.

The effects of some physiological conditions on the levels of L-histidine, carnosine, and anserine were examined in skipjack tuna, *Katsuwonus pelamis*. Also examined were the turnover rates of L-[U- 14 C] histidine in skipjack blood and skeletal muscle, the metabolic interrelationship among several organs, and interconversion between histidine and the dipeptides. In white muscle of control tuna, these compounds in total occurred at a mean $\pm$ SD concentration of 147.4 ± 3.5 $\mu\text{mol/g}$ muscle ($n = 5$) histidine, 93.5 ± 9.2 ; carnosine, 2.90 ± 1.66 ; anserine, 51.1 ± 10.2 $\mu\text{mol/g}$ muscle), but in red muscle the total concentration was only 21.3 ± 2.1 $\mu\text{mol/g}$ muscle. Exhaustive burst swimming did not lead to any large changes in these concentrations, whereas starvation markedly affected them. In white muscle histidine decreased to 30% and 4% of control levels after 5 and 12 days of starvation, respectively; carnosine increased 3.7- and 8.6-fold, while anserine decreased in the initial stage but recovered to control levels during sustained starvation. A similar pattern also was observed in red muscle. The metabolic half-life of ^{14}C -labeled histidine was 0.72 ± 0.124 h ($n = 3$) in skipjack blood, and 66 and 52.5 h in white and red muscle, respectively. The label was incorporated into muscle carnosine and anserine, though the incorporation was fairly slow. The label was transported rapidly from blood into liver and muscles and also from white muscle into red.

Barlow, Jay and Rennie S. Holt. 1986. Proportions of species of dolphins in the eastern tropical Pacific. NOAA-TM-NMFS-SWFC-56, 44 p.

Overall proportions of the various dolphin species involved in the eastern Pacific tuna fishery are calculated from sightings made from fishing and research vessels. Considerable geographic variability is found in dolphin proportions. Overall species proportions are therefore calculated from a weighted sum of the species proportions within 5-degree geographic strata. Variances in the estimates of these proportions are calculated using bootstrap methods.

The effects of various sighting factors are tested using bootstrap statistics. Estimates of species proportions from data collected on tuna vessels are found to be significantly different from estimates based on research vessel data.

Support is given for the superiority of research vessel estimates over those made from tuna vessel sightings. Other factors tested include sighting distance, sighting cue, school size, year, sea state, season, search effort, sighting platform, and distance from previous sighting.

Nearest neighbor analyses show considerable geographic heterogeneity in species compositions, even within 5-degree squares. Schools of like species are clustered together. These results emphasize the importance of random or systematic search patterns in surveys of dolphin species proportions.

Govoni, J. J., G. W. Boehlert, and Y. Watanabe. 1986. The physiology of digestion in fish larvae. *Environ. Biol. Fishes* 16(1-3):59-77.

The acquisition, digestion, and assimilation of food is critical for the growth and survival of fish larvae; a fish larva either grows or it perishes. Fish larvae are characterized by digestive systems and diets that differ from adults. Larvae undergo a pattern of trophic ontogeny, changing diet with increasing size, and these changes result in differences in digestive requirements. At first feeding, the larval alimentary canal is functional, but is structurally and functionally less complex than that of adults. The larval alimentary canal remains unchanged histologically during the larval period before transformation. During transformation, major changes that result in the development of the adult alimentary canal occur. The ontogeny of the alimentary canal differs in different taxa, and experimental evidence suggests that functional differences exist as well. Assimilation efficiency may be lower in larvae than it is in adult fishes, due to a lack of a morphological and functional stomach in larvae, but the question of improving assimilation efficiencies during larval development before transformation remains unresolved.

Harrison, J. T., III. 1986. Recent marine studies at Enewetak Atoll. Marshall Islands. *Bull. Mar. Sci.* 38:1-3.

Hightower, Joseph E. 1986. Sampling strategies for the Washington-Oregon-California sablefish fishery. NOAA-TM-NMFS-SWFC-63, 43 p.

Johanos, T. C. and J. R. Henderson. 1986. Hawaiian monk seal reproduction and injuries on Lisianski Island, 1982. U.S. Dep. Commer., NOAA-TM-NMFS-SWFC-64, 7 p.

Data on the Hawaiian monk seal, Monachus schauinslandi, including pup production, pupping locations, and injuries at Lisianski Island in 1982 are presented. Twenty-eight pups were born, of which 26 survived to weaning. Of the observed births, 75% occurred on the east side of the island.

Average nursing period for 14 mother-pup pairs was 37.4 days. One exchange of pups was observed. Ten seals were injured while personnel were present on the island. Four of these injuries were attributable to attacks by adult male seals.

Kam, A. K. H. 1986. The green turtle, Chelonia mydas, at Laysan Island, Lisianski Island, and Pearl and Hermes Reef, summer 1982. U.S. Dep. Commer., NOAA-TM-NMFS-SWFC-65, 49 p.

During the spring and summer of 1982, green turtle populations were studied at three sites in the Northwestern Hawaiian Islands: Laysan Island, Pearl and Hermes Reef, and Lisianski Island. A total of 149 individuals (54 adult females, 26 adult males, and 69 immature animals) were identified with metal tags. Of these, 108 turtles were newly tagged, and 41 turtles were seen with tags from previous studies.

On Laysan Island between 16 March and 30 June, 30 turtles were identified. Of six animals resighted from previous years, two were remigrations in that they first appeared at Laysan, nested at French Frigate Shoals (FFS), and reappeared back on Laysan. A total of 45 excavated pits were discovered and marked. Two animals were monitored during nest excavation and egg deposition. Census counts during the day and at night indicated low numbers of basking animals.

On Pearl and Hermes Reef between 2 and 6 July, 27 turtles were individually identified; census counts indicate at least 35 were present. Eleven turtles were recorded as tag recoveries with one adult female previously observed nesting at FFS, appearing at Pearl and Hermes Reef, a minimum distance of 560 n mi. A total of 22 pits were found on Southeast Island and North Island. No turtles were found nesting during night surveys. Highest counts of basking turtles at both Southeast Island and North Island were made at night.

On Lisianski Island between 17 March and 13 September, 92 turtles were identified. Twenty-four animals were recorded from previous years; five of these reflect long-distance migrations. Nesting began on 28 May and the last nest was completed on 14 August. A total of 47 pits were found on the island. Only six egg clutches were found and 72% of the hatchlings had apparently emerged to the surface. The greatest incidence of basking behavior occurred at night.

Lo, Nancy C. H. 1986. Modeling life-stage-specific instantaneous mortality rates, an application to northern anchovy, Engraulis mordax, eggs and larvae. Fish. Bull., U.S. 84(2):395-407.

Life-stage-specific instantaneous mortality rates (IMRs) are often estimated individually for each life stage of an organism using regression analysis. A single estimation procedure for all life stages may be preferable because it would increase the overall precision of the IMRs and also provide a more realistic mortality model. Two such procedures were developed in this paper. One is a single-equation model where regression estimates of all IMRs are obtained by fitting a single survivorship function to the entire data set. The other is the maximum likelihood estimator. These models were compared using northern anchovy egg and larval data. The survivorship functions of each were, respectively, exponential and Pareto functions.

MacFarlane, R. B. and P. E. Benville, Jr. 1986. Primary and secondary stress responses of striped bass (Morone saxatilis) exposed to benzene. Mar. Biol. (Berl.) 92:245-254.

Striped bass (Morone saxatilis) were collected from the San Francisco Bay-Delta estuary in 1982, from areas distant from pollution sources. After acclimatization, plasma cortisol concentration (primary response) and blood biochemicals indicative of energy mobilization (secondary responses) were followed in individuals exposed to sublethal levels of benzene for up to 21 d. Despite the persistence of benzene in blood and liver tissues for the exposure duration, stress responses were moderate and returned to control values within the initial 7 d. Blood and liver rapidly accumulated benzene to approximately 20 times the exposure concentrations (0.1 and 1.0 ppm). Concentrations of cortisol and secondary response variables were not proportional to benzene exposure or to accumulation levels, however. Plasma cortisol concentrations increased two- to three-fold at 8 h and returned to control levels prior to 48 h exposure. Glucose, lactate, H₊, protein and triglyceride concentrations were elevated during the initial 4 h to 7 d, with protein and triglyceride returning to normal levels prior to the other secondary response variables. From the perspective of the general adaptation syndrome (GAS), benzene activated the hypothalamo-pituitary-interrenal axis, resulting in clinical stress responses characteristic of an alarm reaction. The time-courses and amplitudes of primary and secondary responses to benzene suggest the sensory perception of a noxious agent eliciting mild, acute stress followed by adaptation.

Myrick, Albert C., Jr. 1986. Procedures for sampling dolphins: A handbook for shipboard observers. NOAA-TM-NMFS-SWFC-62, 69 p.

Myrick, A. C., Jr., A. A. Hohn, J. Barlow, and P. A. Sloan. 1986. Reproductive biology of female spotted dolphins, Stenella attenuata, from the eastern tropical Pacific.

Reproductive parameters were estimated from about 4,700 female spotted dolphins collected in the eastern tropical Pacific from 1973 to 1981. From this sample, specimens for which ages were estimated were divided into two subsets and were used to estimate age-specific rates for the northern offshore stock of this species. The youngest sexually mature individual was 10 years old; the oldest immature was 17 years; the youngest and oldest pregnant individuals were 10 and 35 years, respectively. There was high individual variability in the accumulation corpora with age; the ovulation rate appears to slow abruptly after the eighth ovulation. Average age at attainment of sexual maturity (ASM) for all years ranged from 10.7 to 12.2 years ($\bar{x} = 11.4$ years) for two sets of age estimates; no significant temporal change in ASM was detected. Correlation between color phase and state of sexual maturity suggests that color phase may be a good indicator of maturity for this stock. The average annual pregnancy rate was about 0.33; this rate did not change significantly with age. The calving interval was 3.03 years (SE = 0.205). The lactation period was 1.66 years, but there was a significant increase noted in the percent lactating from 1973 to 1981. A low percentage of postreproductive females was found in the sample (0.4%) indicating that reproductive senescence is of little importance in reproductive rates of this stock.

Olson, R. J. and C. H. Boggs. 1986. Apex predation by yellowfin tuna (Thunnus albacares): Independent estimates from gastric evacuation and stomach contents, bioenergetics, and cesium concentrations. Can. J. Fish. Aquat. Sci. 43:1760-1775.

Three approaches for estimating predation by yellowfin tuna (Thunnus albacares) were compared: (1) stomach analysis adjusted for gastric evacuation; (2) food energy required as a function of swimming speed in yellowfin tracked at sea; and (3) food intake needed to maintain observed cesium concentrations. Gastric evacuation data from captive yellowfin were best fit by linear functions of time for four foods. Fish with high lipid content (mackerel, Scomber japonicus) were evacuated at a slower rate (proportion per hour) than smaller fish (smelt, Hypomesus pretiosus), squid (Loligo opalescens), and small fragile fish (nehu, Stolephorus purpureus), all of which had lower lipid contents. Tuna captured in the eastern Pacific had daily rations averaging 3.9% of body mass based on stomach contents and gastric evacuation rates, 5.2% based on bioenergetics estimates, and 6.7% based on the cesium estimate. Swimming costs accounted for one-third to one-half of the energy budget. Annual predation by the eastern Pacific yellowfin population averaged 4.3-6.4 million metric tons during 1970-72, depending on the method used for estimating ration; 34% was frigate tunas (Auxis spp.). High growth and turnover rates (P/B ratios) of tropical tunas in

contrast with low conversion and trophic transfer efficiencies suggest a trophic structure that differs from more productive ecosystems.

Polovina, J. J. 1985. Artificial reef technology in Japan. Office of Naval Research, Far East Sci. Bull. 10(4):15-20.

Polovina, J. J. 1985. Fisheries resource assessment of the Mariana Archipelago, 1982-85. Mar. Fish. Rev. 47(4):19-25.

Polovina, J. J. 1986. Corrections for the listings of the ECOPATH model. Fishbyte [ICLARM] 4(1), 21 p.

Polovina, J. J. 1986. A variable catchability version of the Leslie model with application to an intensive fishing experiment on a multispecies stock. Fish. Bull., U.S. 84:423-428.

A variable catchability version of the Leslie model is developed which permits the catchability of one species to vary inversely with the abundance of competing species. This model is used to fit data from an intensive fishing experiment conducted on a multispecies bottom fish stock in the Marianas where catchability of a subordinate species is inversely related to the abundance of a more dominant species. Analysis of this multispecies intensive fishing experiment produced estimates of exploitable bottom fish density in the 150-275 m depth range of 10,156 fish per mi^2 or 1,354 fish per n mi of 183 m (100-fathom) contour.

Priede, I. G. 1986. The limitations of fish tracking systems: Acoustic and satellite techniques. NOAA-TM-NMFS-SWFC-61, 17 p.

Smith, Paul and Daniel Goodman. 1986. Determining fish movements from an archival tag. NOAA-TM-NMFS-SWFC-60, 13 p.

Smith, R. C., P. Dustan, D. Au, K. S. Baker, and E. A. Dunlap. 1986. Distribution of cetaceans and sea-surface chlorophyll concentrations in the California Current. Mar. Biol. 91:385-402.

A census of marine mammals was conducted off the coast of California (USA) in 1979-1980. The distribution of sea-surface chlorophyll was determined at the same time by onboard fluorometry and by remote sensing using the Coastal Zone Color Scanner on the Nimbus-7 satellite. Comparisons of species and chlorophyll distributions indicate that marine mammals are not randomly distributed with respect to chlorophyll. Cetaceans were more abundant in the productive coastal waters than in the offshore oceanic waters of the California Current. This supports the hypothesis that the distributions of some cetacean species may be related to the mesoscale features that are manifest in the patterns of chlorophyll as revealed in the satellite imagery. It is

suggested that oceanic chlorophyll may be used as a habitat descriptor for selected marine mammals, and that remote sensing will provide complementary data useful in the interpretation of observed distribution patterns of marine mammals and in the estimation of their abundance.

Squires, Dale. 1986. Ex-vessel price linkages in the New England fishing industry. Fish. Bull., U.S. 84(2):437-442.

This study examines the direction of ex-vessel price linkages between the three New England ports of Boston, New Bedford, and Gloucester. Within-sample bivariate tests of Granger causality are applied for monthly data from 1965 through 1981. It is found that cod and haddock prices are formed in New Bedford, that pollock prices are simultaneously formed between Boston and Gloucester, and that a spurious relationship exists for flounder prices between the three ports. The hypothesis is advanced that this spurious relationship may be due to flounder price leadership from outside the region, most probably the New York Fulton Fish Market.

Ueber, Edward. 1986. Fillet yields of Dover sole versus depth of capture and length. N. Am. J. Fish. Manage. 6:282-284.

The fillet yield (100% x fillet weight round weight) of Dover sole (Microstomus pacificus) caught off central and northern California was examined with respect to fish total length and depth of capture. The yield from Dover sole caught at depths greater than 458 m was not related to fish length. However, the yield from fish caught at shallower depths was correlated with fish length; the maximum yield was obtained from fish 40-42 cm long. Fillet yield was substantially lower for fish larger than 42 cm. A comparison of the yields of shallow- and deep-caught fish showed that shallow-caught fish had a 4.1% higher yield.

Wahlen, Bruce E., G. Jay Walker, Ruth B. Miller, and Charles W. Oliver. 1986. Composition of the incidental kill of small cetaceans in the US purse-seine fishery for tuna in the eastern tropical Pacific, 1982 through 1984. Rep. Int. Whal. Commn. 36:369-374.

Composition of the small cetacean incidental kill by US registered purse-seiners fishing in the eastern tropical Pacific from 1982 to 1984 is reported by area, species, stock, sex, length and reproductive condition. The data were collected by Inter-American Tropical Tuna Commission and National Marine Fisheries Service technicians placed aboard a total of 162 vessel-trips made during these three years. Differences between the data treatment here as opposed to that in two previous papers are discussed.

Wetherall, J. A. 1986. A new method for estimating growth and mortality parameters from length-frequency data. Fishbyte [ICLARM] 4(1):12-14.

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Balazs, G. H. and R. G. Forsyth. 1986. Status and ecology of marine turtles at Johnston Atoll: 1985 assessment. NMFS, NOAA, Honolulu, Hawaii, SWFC, Admin. Rep. H-86-9, 22 p.

Everson, A. R. 1986. Closed season as a management policy in lobster fisheries. NMFS, NOAA, Honolulu, SWFC Admin. Rep. H-86-7, 8 p.

Gilpatrick, J. W., Jr. and G. J. Walker. 1986. Osteological catalog: User's guide and documentation. A microcomputer-based system for managing osteological specimens. NMFS, NOAA, SWFC, La Jolla, Admin. Rep. LJ-86-14.

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Huber, H. R., L. Fry, A. Rovetta, S. Johnston and J. Nusbaum. 1986. Studies of marine mammals at the Farallon Islands, 1983-1985. NMFS, NOAA, SWFC, La Jolla, Admin. Rep. LJ-86-17C.

Hudgins, L. L. 1986. Economic issues of the size distribution of fish caught in the Hawaiian skipjack tuna fishery, 1964-82. NMFS, NOAA, SWFC, Honolulu, Admin Rep. H-86-14, 16 p.

Huppert, D. and C. Thomson. A report on the PACFIN research data base for 1983-1984. NMFS, NOAA, SWFC, La Jolla, Admin. Rep. LJ-86-20.

King, D. M. 1986. Global tuna markets and Hawaii aku. NMFS, NOAA, SWFC, Honolulu, Admin. Rep. H-86-12C, 15 p.

Kirch, H. M. 1986. An evaluation of microcomputer project management programs for use at the Southwest Fisheries Center. NMFS, NOAA, SWFC, La Jolla, Admin. Rep. LJ-86-12

Laurs, R. M., K. A. Bliss and J. A. Wetherall. 1986. Preliminary results from R/V Townsend Cromwell South Pacific albacore research survey. NMFS, NOAA, SWFC, La Jolla, Admin. Rep. LJ-86-13.

Lowry, M. S. 1986. Sex determination of the California sea lion (Zalophus californianus) from canine teeth. NMFS, NOAA, SWFC, La Jolla, Admin. Rep. LJ-86-15.

- Majors, A. and F. Miller. 1986. Summary of the 1985 North Pacific albacore fishery data. NMFS, NOAA, SWFC, La Jolla, Admin. Rep. LJ-86-10.
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Approved by Center Director

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